THE ILLUMINATING ENGINEER

THE JOURNAL OF GOOD LIGHTING

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OFFICIAL ORGAN of
The Illuminating Engineering Society
(Founded in London. 1909; Incorporated 1930)
and of
THE ASSOCIATION OF PUBLIC LIGHTING ENGINEERS
(Founded 1923; Incorporated 1928)

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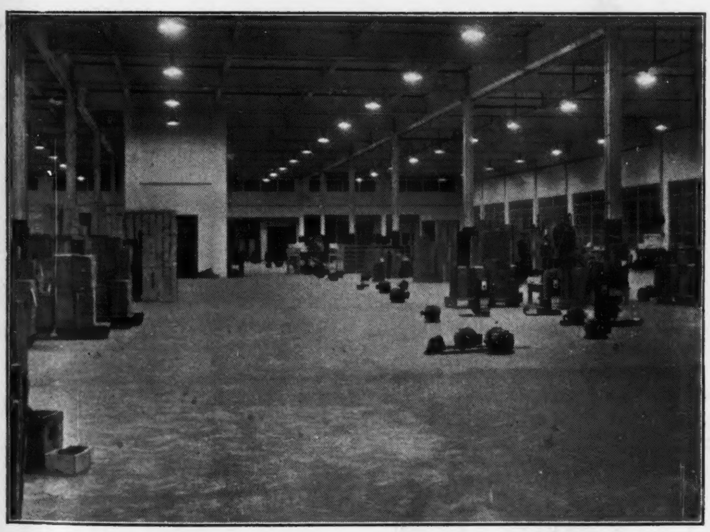

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Street Lighting in the United States

THE paper on this subject, read by Mr. Grant Mackenzie at the meeting of the Illuminating Engineering Society on April 21st, was interesting not only as a survey of methods of street lighting in the United States but also for the fact that it presented a fresh point of view. In Great Britain we are accustomed to the conception that street lighting is fundamentally the province of the local authority, elected by the residents of a city or borough, ministering to their needs and carrying out their wishes. The manufacturer of lighting equipment and the gas or electric supply undertakings, strictly speaking, only enter upon the scene when an improvement in public lighting has been decided upon and when the question arises how best to give effect to this decision.

In the United States evidently the position of the manufacturer and the public utility undertaking in connection with street lighting is a much more active and aggressive one. These concerns are naturally "out for business," and they do not wait for it to arrive. On the contrary they create the demand by appealing direct to the public, and especially to merchants and others who have a direct commercial interest in better lighting. But the process does not stop here. The manufacturers and public utility undertakings having, by appeal to civic pride or business instincts, created a public opinion favourable to improvements, proceed to demonstrate how money for these improvements may be raised. Methods of financing street lighting vary considerably. Mr. Mackenzie enumerates six main schemes, and there are others. But the tendency seems to be to induce those directly interested in better lighting (e.g., the owners of shops or offices facing the street) to pay for the initial cost of installation, whilst the local authority meets the cost of maintenance out of revenue in the usual way.

One can understand how such methods may have a distinct influence on American practice in street lighting. They do, doubtless, facilitate the super-lighting of main thoroughfares, especially those of the commercial type, on a scale unusual or even non-existent in this country. On the other hand one may hazard the suggestion that possibly some local authorities may come to expect and await stimulus of this kind and react only when it is applied—with the result that main thoroughfares and wealthy and commercial sections of cities are well lighted, whilst the side streets and the poorer quarters are apt to be neglected. This, at least, was the impression gained by some of the visitors to the International Illumination Congress of 1928. American cities, it was remarked, usually excelled in the lighting of main thoroughfares, but did not attain such a good average level throughout the city as is usual in Great Britain.

In theory our method of dealing with public lighting, characteristic of this country, is a reasonable and democratic one, but it has drawbacks. In general, public authorities, if somewhat slow in action, do their work conscientiously and well. Nevertheless they would be the better for occasional outside stimulus—would, indeed, sometimes welcome it! Somehow one cannot imagine local gas or electric supply undertakings exercising quite such a direct influence on lighting here, determining the nature of the improvement, and interesting themselves in the issue of bonds to meet the cost of installation. But it should be possible to help the authorities to take action by educating the ratepayer and by appealing to that civic pride which plays such an important role in American cities, and is latent in most British cities also. Influence of this kind ought to be more strongly exerted by such bodies as the Illuminating Engineering Society and the Association of Public Lighting Engineers, which represent many different shades of opinion all interested in better lighting. Manufacturers of lighting equipment would do well to aid and foster action through these channels.

We may conclude this note by commenting on one aspect of public lighting, which is becoming increasingly urgent in this country—the need for central supervision. The drawbacks of many small adjacent areas acting quite independently in lighting matters are strikingly illustrated in Greater London. But the same applies throughout the entire country. Our cities are no longer isolated units but are becoming linked by arterial routes along which a continually increasing stream of night-traffic pours. In the United States the lighting of rural highways is a problem as complex as the illumination of our arterial roads, and vaster. In both countries there is a growing recognition that public lighting should be treated no longer as a parochial duty but as a national obligation.

Modern Gas Lighting

PAPERS on gas lighting nowadays are not so frequent as one could wish but when they do occur they are the more welcome. Mr. J. C. Clark in his address to the London and Southern District Junior Gas Association on April 24th raised quite a number of interesting points. There was, firstly, his discussion of the operation of cluster burners, where two opposing factors seem to be working—(1) the gain in efficiency due to the higher temperature of mantles very near together and (2) the tendency of some mantles to obstruct the light from others. His comments on the working of the British Standard Specification of Street Lighting (especially in so far as it seems to encourage the use of concentrated beams directed on the test point) were also pertinent. We confess that we have some sympathy with the suggestion that an allowable deterioration of 50 per cent. is exceedingly liberal! One other point, the unpleasant effect of a lamp with a sharp angle of cut-off swinging freely in a breeze, is worthy of notice. We do not recall having observed this effect in street-lighting though it is occasionally in evidence on the tube railways. Evidently a lighting unit with a sharp cut-off of this nature needs rigid support and its desirability as a centrally suspended source on wires spanning a street seems doubtful.

Of special interest was the discussion by Mr. Clark of methods of rating candle-power—a topic that received notice in the discussion of Mr. Oughton's recent paper before the Illuminating Engineering Society. Mr. Clark rightly deprecated the selection of candle-power at some particular angle, which may easily be accentuated by freak methods. Yet he was somewhat dubious of the utility of spherical values and seemed to prefer mean hemispherical values. We cannot help thinking that mean spherical candle-power or total lumens emitted furnish the best basis of comparison between units having widely different distributions of light. Even to-day it is not unusual to find that the candle-power assigned to a lamp is the maximum value. This, perhaps, does not matter so very much if the polar curve is also furnished. But the method is apt to prove misleading when this maximum is divided by the gas consumption in cubic ft. per hour, or B.Th.U.'s per hour, and the result is presented as the efficiency!

If the total flux of light in lumens is divided by the consumption we get a proper basis of comparison between lamps. If the mean spherical candle-power is used we still do so. But if the mean lower hemispherical candle-power (which by the aid of an over-reflector might be made nearly double the mean spherical candle-power) is similarly divided by the gas consumption we may get much too high a figure for the estimated "efficiency." And if (as we have known take place) an enthusiast argues that the mean lower hemispherical candle-power, being confined to one hemisphere, should be divided by only *half* the gas consumption, one gets a more extravagant value still!

To anyone familiar with photometry it may seem superflous to point out these fallacies but there does seem some danger that the inexpert may be misled by the use of mean lower hemispherical candle-power. That is why we prefer comparisons between lighting units to be made in terms of total flux of light in lumens; although admittedly mean lower hemispherical candle-power may and does prove quite useful in calculating illumination in practice.

There is just one other point we might select from Mr. Clark's paper—his mention of special mantles impregnated to emit light resembling daylight in colour. We believe that some reference to this point was made in Mr. Oughton's paper. The principle of producing artificial daylight by such means is one of considerable scientific interest, and we should imagine that daylight units enjoying such mantles in connection with suitable screens might prove both accurate and efficient. We should, however, like to see this promising idea more energetically developed. It seems quite a long time since the idea was first suggested. Yet little has been heard about the constitution of such mantles, and artificial daylight units utilizing incandescent gas do not seem widely known or used.

The Illuminating Engineering Society

ANNUAL GENERAL MEETING.

THE Annual General Meeting of the Illuminating Engineering Society was held in the Lecture Theatre of the E.L.M.A. Lighting Service Bureau (15, Savoy Street, Strand, London, W.C.), at 6 p.m. on Tuesday, May 19th, the President (Lieut.-Colonel Kenelm Edgcumbe) in the chair.

After the minutes of the last meeting had been taken as read, the HON. SECRETARY read out the names of applicants for membership, which were as follows:—

Ordinary Members:—

Lacey, S. ....The Gas Light & Coke Co., Horseferry Road, Westminster, S.W.1.

Marshall, J. C. ...... Ophthalmic Surgeon, 126, Harley Street, London, W.1.

Robinson, G. S. ....Illuminating Engineer, The Research Laboratories of the General Electric Co. Ltd., Wembley, London, N.W.

The names of applicants present at the last sessional meeting of the Society were read again, and these gentlemen were formally declared members of the Society.*

At the request of the President the HON. SECRETARY (Mr. J. S. Dow) then presented a summary of the Annual Report of the Council, which, as usual, had been circulated to all members of the Society. He singled out for special mention the fact that the Society had become an incorporated body during the past session, the completion of arrangements for the administration of the Leon Gaster Memorial Fund, and the continually extending work of the Technical Committee, and pointed out the improvement that had taken place in the financial position of the Society during the past few years.

The following resolution was then moved by Mr. JUSTUS ECK and seconded by Mr. A. BLOK, both of whom expressed their appreciation of the progress which the Society had made:—

"That the Report of the Council for the Session 1930-31 and the accounts of the Illuminating Engineering Society for the period from January 1st, 1930, to December 31st, 1930, be hereby adopted, and that a vote of thanks be extended to the President, Council and Officers for their efforts on behalf of the Society during the past session."

This resolution having been declared carried unanimously, the President briefly returned thanks on behalf of the Council and Officers. In so doing, he referred to the desire of the Council to obtain for the Society papers of an original and outstanding character, worthy of the award of the Leon Gaster Premium. He also alluded to the forthcoming International Illumination Congress, expressing the hope that a considerable number of members of the Society would attend.

The following resolution was put to the meeting by THE PRESIDENT, seconded by Mr. W. R. RAWLINGS, and declared carried unanimously:—

"That this Meeting records its appreciation of the services of Messrs. Robert J. Ward & Co., as Honorary Auditors of the Society, and requests them to act in this capacity for the next session."

(*The Annual Report of the Council and the Accounts of the Society for the past year will appear in our next issue.*—ED.).

* *The Illuminating Engineer*, May, 1931, p. 111.

TECHNICAL SECTION

COMPRISING

Transactions of The Illuminating Engineering Society and Special Articles

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

Some Aspects of Street Lighting in the United States

By W. GRANT MACKENZIE, B.Sc.

(Paper read at the meeting of the Illuminating Engineering Society, held at the House of the Royal Society of Arts, 18, John Street, Adelphi, London, W.C., at 7 p.m., on Tuesday, April 21st, 1931.)

IT is my intention to deal with this subject in the literal meaning of the title which I have chosen for my paper. Besides the actual installation of street-lighting equipment, there are many intensely interesting aspects to be considered—such as promotion, financing and selling of any proposed street-lighting scheme before the order is placed and the equipment installed. Time will permit me to deal with only some of these aspects.

At the outset I would like to introduce the explanation that my whole paper has reference to street lighting in the United States of America. Now, in the U.S.A. there are very few, if any, municipally owned generating stations, the bulk of the power being supplied by what are known as public utility companies.

Except in the case of municipal street-lighting plants, the street-lighting system is generally operated and maintained under contract with the local public utility company, and this unquestionably is the most effective means of providing adequate street lighting. This arrangement means that a power company is just as keen on selling a lighting installation to a municipality as are the manufacturers of the necessary equipment; the reason being, of course, that increased street-lighting installations mean increased load for the power company. While a municipally owned power station can look upon street lighting as a load builder, it can hardly be termed a source of revenue, except, of course, from an increase in rates point of view. In some large cities the municipalities purchase electrical energy in bulk and operate and maintain their own street-lighting system. This explanation should be borne in mind when I come to a description of financing a street-lighting installation.

Street-lighting Practice.

I propose, in a way, to put the cart before the horse, inasmuch that I will describe briefly the systems in vogue before dealing, in more detail, with the commercial and financial aspects.

Developments in the art of street lighting have progressed so rapidly in the past few years that a general review of modern street-lighting practice would appear to be opportune at this time, particularly as the commercial application of the many new ideas in outdoor lighting has not kept pace with the developments.

It will doubtless be surprising to you to learn that the consensus of opinion among sixty-one illuminating engineers, who visited the U.S.A. to attend the seventh meeting of the International Commission on Illumination at Saranac Inn, New York, in September, 1928, was that, with the exception of the super whiteway installations, the standards of illumination on the minor streets of American cities was lower than the prevailing standards abroad. This is doubtless due to the fact that in other countries the high-efficiency open-type arc lamp was retained until the gasfilled lamp was substituted, whereas the U.S.A. changed nearly twenty years ago from the open arc to the longer burning but less efficient enclosed arc, and thus cut down their illumination materially. Later, when a change was made from the enclosed arcs to gasfilled lamps, they started at about one-half the candle-power per lamp, as compared with European conditions when similar changes were made.

The major purposes of street lighting, as defined by the Street-lighting Committee of the Illuminating Engineering Society (U.S.A.) are:—

1. To promote safety and convenience in the streets at night through adequate visibility.
2. To enhance the community value of the street.

The first purpose applies to all classes of streets, and the second purpose to important boulevards and main business streets, which may be classified as whiteway or super-whiteway systems.

Planning for Street Lighting.

I do not think that the U.S.A. stands alone in the fact that improvements in municipal street-lighting systems are generally undertaken piecemeal, and unless a comprehensive, well-co-ordinated street-lighting plan covering the entire city has been prepared previously, such installations are likely to appear very much like a patchwork quilt with many different designs and types of equipment.

The majority of the American citizens, living in cities which have modern and efficient street lighting, derive a certain amount of civic pride from the installation, and the city fathers themselves consider a well-spoken-of and well-known street-lighting scheme to be an excellent advertisement for the city concerned. Bearing this aspect of civic pride in mind, it is not difficult to realize that street lighting is considered an important phase of city zoning, and on continually increasing occasions, where a city planning commission or association exists, the plans for the complete street-lighting system are being prepared in collaboration with such authorities.

The street-lighting plans referred to provide for a system of illumination graduated in accordance with

the character of the streets and the volume of pedestrian and vehicular traffic. They also specify the design of standard luminaire, so that a uniform system may be adopted which will be in keeping with the size and importance of the community. The appearance of many otherwise attractive streets is often spoiled by unsuitable street-lighting equipment, or by privately owned lighting equipment installed by merchants outside their premises for advertising purposes. It is believed that ordinances should be provided to control these activities, and prohibit the indiscriminate installation of lighting equipment beyond the property lines of buildings.

Distribution Systems.

There are in common use in the U.S.A. two systems of distribution for operating street-lighting installations, viz., the series and the multiple. The series system is generally preferred owing to its simplicity of control and economy in installation and operation.

Because of the fact that arc lamps, originally used as street-lighting illuminants, were operated at 6.6 or 7.5 amperes, these ratings for street-lighting circuits became standard throughout the country, and series incandescent lamps were developed for operating on such circuits. The larger sizes of incandescent lamps, however, are operated at higher currents, and there is a marked tendency throughout the country towards the adoption of 20-ampere circuits.

Street-lighting Controls.

The key to the successful and economic operation of a modern street-lighting system lies in the scientific control of the circuits and lamps. There are four methods of control in general use in the United States, viz.: (*a*) Time switches, (*b*) remote-control switches, (*c*) multiple relays, and (*d*) high-frequency relays.

Another type of apparatus which is considered an essential part of a series system, and for which provision is made when designing an installation, is the constant-current regulator. These transformers are used to maintain a uniform current in the lamp circuit, regardless of fluctuations in the circuit load. The type in general use is known as a moving-coil transformer, because the secondary coil is floating above the primary coil, and changes its position relative to the primary coil with variations of the secondary load.

In order to keep this paper within bounds, I will not make any detailed reference to the remaining equipment—such as cable, ornamental standards, series-series and auto-transformers, disconnecting pot-heads, ornamental luminaires, sockets, etc., —of any installation. Methods adopted for financing street lighting may prove to be of greater interest.

Street Lighting Specifications.

At this stage it may be of interest to make some reference to the code of street lighting prepared by the American Illuminating Engineering Society (1929-30). In some respects this presents an interesting contrast with the British Standard Specification for Street Lighting (September, 1927), though it is understood that the latter is now undergoing revision, and it is possible that ultimately the two may be found to agree more closely.

In both cases streets are divided into eight classes. The classes A to H, enumerated in the British Standard Specification, indicated in what follows by "B.S.S.," however, are based entirely on values of minimum illumination; whereas in the code the classes represent different varieties of streets as follows: Heavy traffic thoroughfares, medium traffic thoroughfares, light traffic thoroughfares, business streets, residence streets, alleys, park drives, and highways.

Heavy, medium and light traffic thoroughfares are determined as being those which usually carry, in both directions, a maximum of not more than 1,500, 800 to 1,200 and 500 vehicles respectively per hour of the week carrying maximum traffic during the lighting period.

The following table has been taken from the B.S.S.:—

Class	Average Minimum Illumination	Mounting height
A	2 foot-candles and upwards	30 feet
B	1 foot-candle	25 ,,
C	0.5 ,,	21 ,,
D	0.2 ,,	18 ,,
E	0.1 ,,	15 ,,
F	0.05 ,,	13 ,,
G	0.02 ,,	13 ,,
H	0.01 ,,	13 ,,

As regards spacing, the B.S.S. determines this by means of a "spacing height ratio," which is the ratio of the distance between two adjacent light sources to the height of the light source from the ground. It is added that this ratio "should be chosen to give the best distribution of illumination, having regard to all the circumstances of the case in question, but shall in no event exceed 12 inches."

The following are some extracts from the U.S. street-lighting code already referred to:—

In heavy-traffic thoroughfares an 18-ft. mounting height is recommended (between 20 ft. and 30 ft. where trees, etc., do not interfere), with a 150-ft. spacing on each side of the street, and a lamp rating of not less than 10,000 lumens or 1,000 candles.

In medium-traffic thoroughfares the same mounting heights, spacing and lamp ratings apply, except that a "staggered" arrangement is recommended.

For light-traffic thoroughfares mounting heights and "staggered" arrangement spacing are the same, but the lamp rating has a minimum of 4,000 lumens or 400 candles recommended.

Business districts are classified as to vehicular traffic in a manner similar to that adopted for thoroughfares, and the same minimum standards of illumination apply for each class, due consideration being given to other local conditions. For a given size of lamp the minimum mounting height is given as follows:—

For lamps of	Not less than
25,000 lumens and over	24 feet.
15,000 lumens	20 ,,
10,000 lumens and less	16 ,,

For residence non-thoroughfare streets the minimum recommended is an 18-ft. mounting height and spacing of 150-200 ft., with a lamp rating of not less than 2,500 lumens or 250 candles. At closer spacings, preferably not exceeding 125 ft., a mounting height of 15 ft. and 1,000-lumen lamps may be used. Where luminaires are on centre suspension the recommended mounting height is 22 ft. to 25 ft. At intersections of residence streets carrying only local traffic, not less than one 4,000-lumen or two 2,500-lumen lamps should be installed.

For the lighting of highways the minimum recommended is an arrangement of luminaires at mounting heights of 28 ft. or more, and not more than 10 ft. from a point over the middle of the highway. With this mounting height the spacing should not be greater than 325 ft., and 4,000-lumen lamps are considered the minimum. On curved highways, luminaires are mounted over the outside of the curve.

No detailed figures are given for alleys and park drives, but, in general, the practice adopted is to place one or two standards at street intersections

and to divide the distance between intersections into equal distances, these distances varying with the amount of illumination to be supplied.

It will be noted that while the B.S.S. gives the rated illumination in foot-candles the U.S. code refers to the power of the lamp only.

The following data, however, enables some idea of the relation between lumens per linear foot and available illumination to be formed:—

100 lumens per linear foot of street equals: 0.23 foot-candle average horizontal illumination when directional media for light control are not utilized. Or, 0.33 foot-candle average horizontal illumination when efficient directional media for light control are used.

Some Striking Installations.

I have been asked to give particulars of some typical installations in the United States, in order to illustrate the powerful lighting sometimes furnished, and the scale on which new installations are made.

The down-town area of *St. Louis* is splendidly lighted with both single and duplex units. The consensus of opinion is that the light centre of 23 ft. is none too low, and that the real effectiveness of the illumination is due to this height and the design of the luminaire. Some statistics of this particular installation may be of interest:—

Miles of streets lighted	650 (approx.)
Number of lighting standards	32,000 (approx.)
Miles of underground cable	1,600 (approx.)
Number of transformers (from 5 Kv-a. to 80 Kv-a.)	845
Mounting heights of lights:	
Intensified downtown area	26 ft.
Intermediate area...	19 ft.
Residential area	15 ft.
Size of lamps:	
Intensified area	25,000 lumens (2,500 cp.)
	15,000 lumens (1,500 cp.)
Intermediate area	10,000 lumens (1,000 cp.)
Residential area	1,500 to 6,000 (150 to 600 cp.)
Total candle-power in downtown district	5,000,000
Total current consumption is 15,000 kilowatts	

(This is a 20 ampere straight series system.)

FIG. 1.-Typical Granite Combination Lighting Standard with Twin Decorative Lanterns.

Other installations that occur to one are:—

Sheridan Road, Chicago, is an installation of Octagonal Junior units with refractors. 6,000-lumen lamps are used, the light centre is 14 ft. 6 ins. and the standards (all opposite each other) have a spacing of 120 ft.

State Street, Chicago, uses two units per standard, with two 2,000-watt lamps per standard. It is generally agreed that this lighting far exceeds the necessity of street illumination, and comes under the spectacular and advertising classification rather than street lighting.

The *Central Parkway* lighting installation in *Cincinnati* uses a luminaire with 40,000 lumen incandescent lamps (believed to be the largest ever used for street lighting work) and is most effective. The luminaires are of the lantern type, made of bronze, and the results are entirely satisfactory. The spacing is 140 ft., with a height to light centre of 20 ft.

The *Essex County Park Commission Speedway* at Irvington, N.J., has a street width of 38 ft. and the

FIG. 3.—A Night View of Sheridan Road, Chicago.

standards are spaced 80 ft. apart with a mounting height of 14 ft. 6 ins. 600-lumen 20-ampere lamps are used.

FIG. 2.—Showing use of fittings as illustrated in Fig. 1, in Twelfth Street, St. Louis.

Another installation of interest is the *Hudson County Bridge, N.J.*, reputed to be the widest bridge in the world. (I am sorry I do not have exact figures of this installation but trust the illustrations will prove of interest.)

Highway Lighting.

Highway lighting (i.e., the illumination of rural highways resembling "arterial roads") is a subject that is concerning all illuminating engineers in the U.S.A. at this time, and they are doing all possible to promote the general lighting of all "through" highways. A great many members of the driving

FIG. 4.—Day View of the Essex County Park Commission Speedway at Irvington, N.J.

Fig. 5.—Day View of the Hudson County Bridge, N.J.

public recognize the advantages of highway lighting, but it will be difficult to light the highways adequately until legislation is passed whereby the State carries the burden of expense rather than the township or county. In view of this fact, there is a movement in several of the State Legislatures to put highway lighting under State control and financing. When this is accomplished, there will be adequately-lighted highways.

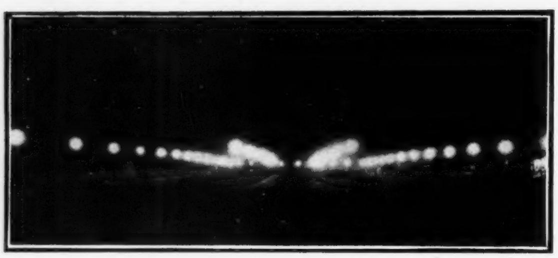


Fig. 6.—Night View of the Hudson County Bridge, N.J.

A somewhat different type of highway lighting is to be seen in the installation in the super-highway through Lincoln Park, Detroit, Mich. Pendant units fitted with two-way refractors are used, there being two units on crooks to each pole, spaced 150 ft. apart along a central parkway between two one-way drives. 6,000-lumen 20-ampere lamps are used.

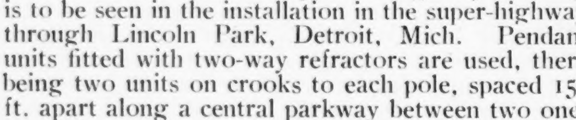


Fig. 7.—Type of Unit used for Highway Lighting.

I have referred to highway lighting as a subject of great importance, since it is probable that the greatest development in street lighting within the next few years will be in this field. While highway lighting, like street lighting, is chiefly considered from the standpoint of safety, it must be remembered that a well-planned installation will:—

Increase property values.
Attract desirable traffic.
Relieve daytime congestion on the roads.
Increase the pleasure of night driving.
Bring the farmer nearer his market and the city nearer the farmer and his family.
Advertise the progressiveness of the locality.

Fig. 8.—Day View of Installation of Highway Lighting Units.

Such lighting, not subject to the possibilities of political manipulation, is naturally of interest to the central station. Aside from the revenue possibilities of this new load, its extension through rural communities will provide means of serving such districts with power for domestic and industrial uses at an almost negligible investment expense.

Fig. 9.—Night View of Installation of Highway Lighting Units.

Some 1925 figures are rather interesting. At that time some 500,000 miles of the 3,002,916 miles of highways of all classes in the U.S.A. were surfaced in one manner or another. If lighting units were spaced 350 ft. apart, about 7,500,000 of them would be required to adequately illuminate these highways. Taking only a 2,500-lumen lamp for this spacing, this means that in 1925 there was an annual potential load of five billion, five hundred and thirty million (5,530,000,000) kilowatt-hours waiting for the central stations of the country to annex to their lines! And thousands of miles of new hard-surfaced highways have and are being completed every year.

Nature of Road Surfaces.

The roadways and streets consist chiefly of asphalt, macadam, tarvia, brick, some tarred wood block, and concrete, with a tendency towards the more or less general acceptance of the latter as the best type. The acceptance of this has been due to the wearing qualities of the concrete under heavy

traffic, even though it is an ideal pavement for lighting conditions. The oil drippings are, of course, somewhat objectionable, but I believe that it would take many years for them to approach a poor quality of macadam or tarvia.

Lighting for Street Traffic Control.

In 1900 there were 8,000 motor vehicles in the U.S.A. In 1929 there were over 26,500,000, a gain of over 331,000 per cent.! The loss of life, personal injury and property damage from automobile accidents has been represented as an economic waste of a minimum of 600 million dollars annually. In addition, congestion and inadequate traffic facilities cost the country over two billion dollars or about 20 dollars per capita annually.

These facts indicate quite clearly the great need of using every possible means to reduce the needless sacrifice of lives and the great waste caused by slowed-up transportation. While there is no substitute for adequate street lighting, there exists in every town and city conditions justifying suitable traffic control and warning beacons marking dead-ended streets and the other impediments to through traffic.

Electric Advertising Signs.

Manufacturers and commercial establishments are realizing more and more the value of electric signs, which, when properly designed, attract the attention of everyone passing within the range of the display. Many electrical displays help make a town or city look more prosperous and wide awake. Carefully designed and well-illuminated displays are as valuable in the daytime as they are at night and refute the belief sometimes expressed that signs detract from the beauty of fine architecture.

Electrical displays also furnish additional illumination on the street that will help to keep people in the shopping district, looking at the advertisers' show windows after dark. The great amount of light given off by many signs and marquees provides one of the best forms of protection, after dark, for the public and for places of business in the vicinity. Times Square, the "Great White Way" of New York, could, in my opinion, quite easily do without street lights—so terrific is the illumination derived from the multitudinous electric signs. However, in general, there is little, if any, attempt made to use or rely upon the floodlighting of buildings or electric signs for street illumination. Street lighting is incidental to the real purpose of the sign. The general effect, nevertheless, is such that the impression is gained of high-intensity street lighting.

The Municipality.

Those interested in the promotion of any street-lighting scheme give careful study to the responsibility of municipalities in connection with lighting. The word "municipal" is derived from two Latin words, *munus* meaning duty and *capio* to take, and it has been pointed out that if municipal electrical engineers would assume definite responsibilities in connection with street lighting, and take a leading part in its promotion, they will fully justify the qualification implied in the derivation of the word "Municipal"—the undertaking of a duty.

Municipal engineers are told that the safety of a community at night depends largely on the adequacy of its street-lighting system. Crimes which may be committed at night on dimly-lighted streets are difficult to accomplish on streets which are adequately illuminated. A survey of street crimes from the police records in Cleveland, Ohio, showed that the installation of a high-intensity street-lighting system in the business district was responsible for a 41 per cent. decrease in night crimes in the newly-lighted areas.

Statistics show that 17 per cent. of night traffic accidents are directly attributable to lack of adequate street lighting, and this is readily understood when it is realized that it requires a longer time to see under dim light than under bright illumination. This split second of time often determines whether there will or will not be an accident.

The welfare of a community also depends upon the adequacy of its lighting system. Adequate street lighting shows up dirt and squalor and is generally the precursor of cleaner and better-paved streets. It increases real estate values, attracts industries and advances civic pride.

In addition to providing for the safety and welfare of the community, adequate street lighting contributes to the comfort and convenience of the inhabitants by enabling them to go about their business or pleasure after dark as easily as they do in the daytime.

Public sentiment demands more and better street lighting and it is the duty of the municipality to take effective measures to provide it. It is also to the advantage of civic officials who have the safety and welfare of the public in their hands to take an active part in promoting more and better street lighting. It is one of the outstanding examples of the progressiveness of the administration which appeals to the taxpayer.

I could continue at length on the manner in which the manufacturer and various associations successfully endeavour to obtain the co-operation of the municipality in street lighting promotion. It should be noted, in passing, how stress is laid on public sentiment with regard to civic pride—an important reason, in my opinion, for different cities paying a great deal of attention to their street lighting. What could perhaps be called "competition," or the desire of one large city to have better lighting than its neighbour, is another point to be considered—and certainly not forgotten in the clever (and tactful) handling of the promotion of street-lighting schemes.

It is recognized that municipal street-lighting appropriations, like most other annual budgets, are generally insufficient to provide for the improvements which appear necessary, and the closest co-operation should exist between the municipal and utility officials so that the funds appropriated may be utilized to the fullest advantage.

Street Lighting Pays for Itself.

Good street lighting pays for itself in enhanced taxable values; the same conditions which make it an asset to real estate developments make street lighting a financially desirable improvement for the city as a whole. Good street lighting improves the character of adjacent buildings, encourages better-class stores and raises the district from poverty and squalor to prosperity. Every city has money enough for better street lighting.

Municipal authorities, unfortunately, are apt to attach too much importance to the cost of adequate street lighting and overlook *the cost of inadequate street lighting*, although the latter may become a heavy burden to the public because of accidents or crimes and other losses attributable to insufficient street lighting. If accidents or crime, caused by inadequate street lighting, resulted in the punishment of those responsible for such lighting, municipal officials would undoubtedly show a greater interest in this matter!

Municipalities are paying little more per capita for street lighting now than they paid many years ago, although the requirements have increased enormously and it is quite evident that existing municipal appropriations for this purpose are

inadequate. It is generally conceded that the annual cost per capita for adequate street lighting in a city should not be less than two dollars. Investigation shows that the average for the United States is less than 90 cents (3s. 9d.), and this does not compare very well with other expenditures, as is revealed in the following chart:—

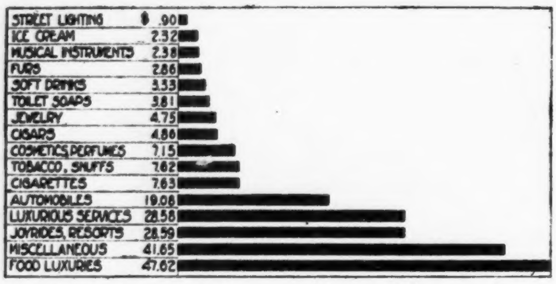


FIG. 10.—Showing comparative amounts expended per capita on street lighting and other commodities.

Financing Street Lighting.

Thus does the manufacturer continually seek to influence the municipality or similar body responsible for the installation. I have enumerated but a few of the methods adopted for arousing the necessary interest of these responsible bodies—and there are many more. But arousing the interest is not enough—how to raise the necessary capital must also be shown. Sometimes the difficulties in this direction are more apparent than real.

There are various ways by which a street-lighting system may be financed and, while local conditions might be responsible for slight variations in procedure, the six plans outlined in Section 15 in the "Municipal Index" of 1926 appear to cover all conditions in general.

"*First*: Payment of the installation costs, operating and maintenance charges by means of direct taxes.

"*Second*: Payment of the installation costs by means of bond issues, in which case the operating and maintenance costs, as well as interest and sinking fund for the bonds, are taken care of through direct taxes.

"*Third*: Payment of installation costs by means of special assessment charges levied on a frontage basis, the operation and maintenance charges to be covered by appropriation from taxes.

"*Fourth*: Payment of the original construction costs by local public service companies, the cash costs and fixed charges of the system to be paid by the municipality (in which case provision is made for the acquirement of the property by the municipality at a given time), on the basis of original cost plus accrued depreciation at such date.

"*Fifth*: Construction costs to be defrayed by some public body other than the municipality itself, in which case provision for payment is usually made on an instalment basis, the deferred payments to bear interest, and the expense of operation and maintenance to be paid from municipal taxes.

"*Sixth*: Local street-lighting systems are occasionally constructed and operated by neighbouring commercial or business men's associations on various plans, according to which costs of construction may be paid for out of association funds, by individual subscriptions, by local assessment on a frontage basis, or by means of general special assessment in the same manner as for street and sidewalk improvements, etc., but costs of operation and maintenance are dealt with in various ways."

In discussing methods of finance one should bear in mind that there are two distinct types of street lighting, utilitarian and ornamental. The former usually consists of overhead lighting units supported by brackets or spanwires and fed from overhead lines. The initial cost is comparatively low and such schemes are usually financed in accordance with the first plan. The cost of ornamental installations, usually operated from an underground circuit, on the other hand, is high, and these are best financed by the third plan.

The difference in the first cost of the two systems is the crux of the problem, and when its relation to the annual street-lighting budget is fully appreciated many of the difficulties experienced in promoting modern street-lighting projects will disappear.

Municipalities with street-lighting services operated under the first plan will enter into contracts with the local public utility company at rates which will include, in addition to the operating and maintenance costs, fixed charges for interest and depreciation on the equipment. In the case of utilitarian street lighting where the fixed costs are low, the rate will bear a direct relation to the cost of current and maintenance. On the other hand, if the same plan is adopted for ornamental street lighting, the fixed charges for interest and depreciation will be high, owing to the greater initial cost of the system and they will form a large proportion of the total rate.

Municipalities pay the public utility company's street-lighting bills out of annual maintenance budgets, and it is obvious that when the public utility rate is burdened with large fixed charges incident to ornamental street-lighting systems the municipalities will not have much money left to pay for adequate service, unless their annual budgets are materially increased. Under such circumstances, the municipalities will be paying fixed charges which should be debited to capital account out of their annual maintenance budget. Under the third plan, the fixed charges would be paid for out of assessments, and the annual maintenance budget would be proportionately relieved. Thus municipalities would have money to spare out of their annual budget to purchase more or better lighting service, or otherwise improve the efficiency of their systems.

By plan No. 2, the installation is financed by bond issues and is satisfactory where the municipality is not over bonded. St. Louis is an outstanding example of the value of the bond issue in developing street lighting. In this city, following a preconceived plan, there has been installed an entirely new ornamental street-lighting system, covering 600 miles of downtown and residence streets. This installation was financed by an eight million dollar bond issue and under this plan the municipality has been able to provide an adequate ornamental system for the residence districts and an ornamental system for the downtown area in which every street is a whiteway, rivalling in intensity the most notable whiteways in other cities.

Plans 4 and 5 possess many disadvantages and are not recommended, although they may be found appropriate under some conditions.

Plan 6, whereby local street-lighting systems may be constructed and operated by neighbourhood commercial associations, has many advantageous features, although involving the expenditure of a great deal of time and effort before the plan can be brought to a successful conclusion.

With the exception of a few municipal light plants, the majority of the street-lighting systems in the U.S.A. are operated and maintained by the electric service companies, and the close co-operation of municipal and utility company officials is essential to the proper development of modern street lighting. To be successful, any plan for

financing street lighting must be equally advantageous to the municipality and to the electric service company. One which relieves the annual rate of the fixed charges for an ornamental installation meets these conditions. Such a plan is advantageous for the municipality because the installation costs under these conditions are not paid for out of the annual appropriations for street lighting, which leaves surplus funds in the budget for the purchase of additional service. A plan of this character is advantageous to the utility company, also because with lower rates the customer is encouraged to purchase more service, thus resulting in the sale of more kilowatt hours.

To promote a street-lighting system successfully under the assessment plan requires the services of petitioners to obtain the necessary majority of property owners' signatures, although one progressive city in the west has been able to obtain these signatures by mail because of the public sentiment in favour of better street lighting.

The striking development of ornamental street lighting in the Middle-West and Western States, where modern methods for financing street-lighting systems have been more generally adopted, is evidence of the value of these methods of promoting more and better street lighting.

All plans for financing such schemes have been included to make the picture of the various methods complete, and they may be used should local conditions warrant. In general, however, plan number one is recommended for utilitarian street lighting, and plan number three for ornamental.

Fig. 11.

Selling Street Lighting.

The position of the Public Utility Company as regards the sale of street lighting is dealt with in a July, 1927, serial report of the Street and Highway Lighting Committee of the National Electric Light Association.

It is pointed out that street lighting is essentially a saleable commodity, and can be made a very profitable part of a public utility company's business, which leads to progress in other directions. Thus an effective street-lighting installation usually leads to better shop window lighting in the vicinity, and encourages improved public lighting elsewhere. The public interest demands much better street lighting than at present, and in the average American city an expenditure of not less than two dollars per capita is considered amply justified.

The central station must organize for the effective merchandising of street-lighting service by making its commercial department fully responsible for the sale of street lighting, by building up a lighting service division, by keeping street lighting and its advantages before the employees at all times and by thoroughly surveying the possibilities for street-lighting development separately and in detail for each community served. A pictorial representation of the comparative value of the street-lighting load in terms of generally recognized load builders is given in Fig. 11.

If the central stations are to assume leadership in promoting adequate street lighting they must adopt and energetically utilize all and every one of the modern methods of salesmanship, advertising, merchandising and sales promotional activities. They must demonstrate the desirability of each community adopting a completely engineered "ultimate plan," definitely establishing all physical elements of a street-lighting system which will provide adequate street-lighting service, including satisfactory appearance, at the minimum cost consistent with such service. Another important point and duty not to be overlooked is the necessity of keeping the subject of good street lighting before civic societies, business men's clubs, chambers of commerce, safety organizations and women's clubs.

Conclusion.

After having given you a few facts of the procedure adopted at the actual installation of a street-lighting scheme, I have endeavoured to explain the relative positions of the manufacturer, the central station and the Municipality in connection with such schemes. To sum up, the manufacturer, having first secured its co-operation, combines with the power company to "sell" the idea of a new or improved street-lighting scheme to a municipality. This is to the advantage of all parties concerned, and by the adoption of such methods and combinations street lighting is making rapid strides in the U.S.A. However, when the public utility companies recognize the value of the street-lighting load and organize for the aggressive promotion of this branch of their service, and when municipalities assume the responsibilities which justify the qualification implied in the explained derivation of the word "municipality," 15,000 kilowatt street-lighting loads (as at St. Louis, Missouri) will be the rule rather than the exception.

I have not been in England long enough to determine the practicability of the American methods in this country, but I look forward to the discussion, which I trust will bring out interesting comparisons. I have given some aspects of street lighting in the U.S.A. and leave it to those of my audience, more experienced than I am in methods adopted on this side of the Atlantic, to submit comparative procedures and discussion in connection with this subject.

Some Aspects of Street Lighting in the United States

DISCUSSION

The PRESIDENT, in opening the discussion, remarked that a general invitation had been extended to members of the Association of Public Lighting Engineers to attend this meeting He was very glad to learn the President (Mr. Thomas Wilkie) and several past-Presidents of the Association were present, and he hoped that they would take part in the discussion.

Mr. S. B. LANGLANDS (Glasgow) said that the paper was a most interesting one. It did seem, however, to convey the impression that competition would cease in this country if lighting concerns were municipally owned. This would not necessarily be the case. There might, for instance, still be keen competition between municipally-owned gas departments and municipally-owned electrical departments—such as were already to be found operating side by side in some cities in this country.

The terms of the B.E.S.A. Specification had been contrasted with the "Code" adopted in America. The Specification was used essentially as a basis and a guide. The work was founded on practice. As a rule the needs of the traffic in a street were of paramount importance. The problem of scrapping installations was an interesting one; there should be no hesitation in scrapping when equipment was obsolete.

In London they had an example of street lighting being supervised by a number of small boroughs, each acting independently. It was a great pity that some form of central control (such as might be exercised by the L.C.C.) did not exist for the whole of London. There should be main guiding principles for important thoroughfares. He believed that in all thoroughfares of importance the minimum size of lamp should be the 500-watt type. The question of highway lighting bristled with difficulties. New arterial roadways were continually being opened up, and when lighting was in the hands of small Urban District Councils, or even County Councils, there was a danger that nothing adequate would be done. He thought that ultimately this question would have to be dealt with by the Government on a national basis.

The idea of public lighting being handled by interested parties, i.e., the manufacturers, who originated schemes and influenced public opinion, was, he thought, distinctively American. He doubted whether the basis of taxation in this country would permit these methods. He could not imagine himself going to a city business club or a Rotary club for assistance in public lighting. The essential thing was to bring home the need for adequate lighting to civic officials, not merely in relation to traffic but as a matter of civic pride. When supply authorities were able to get the merchants keen on window lighting, this was a step forward. No doubt in the future the use of standards for lighting the faces of buildings in shopping areas would follow. But beyond special measures of this kind he did not think it was feasible to rely on the co-operation of frontagers for the public lighting.

He had been delighted with the paper, which was novel and refreshing, and with the slides.

Mr. THOMAS WILKIE (Leicester) also expressed his interest in the novel outlook contained in the paper, which did not review the subject from the standpoint of the public lighting engineer under municipal authority. Mr. Mackenzie had stated that in the United States there were few, if any, municipally-owned undertakings. That, he thought, was the crux of the whole question and illustrated the difference in practice of the two countries. In this country municipal ownership was quite usual, and there was frequently keen competition between gas and electrical undertakings.

Mr. R. BEVERIDGE (Edinburgh) said that the paper was an interesting and enlightening one, coming as it did after the recent visit of members to the International Illumination Congress in the United States, and their reports of American practice. He had been much impressed by the descriptions of the "Whiteway" installations. He would like to know what Mr. Mackenzie himself thought as to the value of these super-installations, and how the lighting compared with that in the most important streets in this country.

Mr. E. L. OUGHTON expressed his interest in the paper. The title was a wide one, but in one respect the matter was limited, as it appeared there was nothing to report regarding gas lighting in the United States. Although American practice was in some respects quite different from that in this country, the paper was well worth study. He wished all lighting undertakings in Great Britain derived as much profit from public lighting as had been shown in one of the charts presented by the author!

Commander HADYN T. HARRISON congratulated Mr. Mackenzie on his paper, which revived interesting memories of the past. The author had given a very curious explanation of the relatively low level of lighting in many American cities, apart from that in the main streets, namely, that this was due to the fact that the long-burning enclosed arc lamp was in use during the interval between the use of the original open arcs and the modern tungsten lamp. When he (the speaker) went to America in 1902 there was a great deal of street lighting with open arcs, whereas in England there was relatively little, because electricity was not available to the same extent. In New York he found that most of the street lighting was by open-type arc lamps with clear glass globes. These were being changed over to long-burning enclosed arcs capable of burning for nearly 200 hours without being touched. It was suggested that for street lighting they were more economical and efficient than arcs of the open type, because with the open type nearly the whole of the light came into the lower hemisphere at 90° and the maximum was at 45°, whereas with the enclosed type at the same wattage the maximum at the angles most important for street lighting was in effect more. Thus the study of illumination had begun, to a large extent, 30 years ago, and the engineers of the Westinghouse Company and many others had already found that the open-type arc was most unsuitable for street lighting. His visit was connected with the intermediate stage when the flame-arc lamp was being generally used.

Some of the streets in the city of London, which were cited as examples of the best street lighting in the country (and he thought they were), were still lit with flame-arc lamps, and only a few years ago the lighting in front of the King's Palace was changed over to flame arcs. He thought that for a real comparison in terms of efficiency, of candle-power and cost, they must go to the flame-arc lamp. That merely showed that candle-power only formed a part of "efficiency" in street lighting. Rating in terms of lumens and candle-power might mean very little. Examples which did not actually give the illumination on the surface of the street were not of much service as comparisons. If the height of the lamp were lowered to within six feet of the ground the maximum average illumination would

be obtained, but the lamp should be put as high as possible for other weighty reasons. The Tungsten lamp might not be as efficient for illumination as the flame-arc lamp, but it was a convenient lamp from the practical standpoint. The question of adaptability for the purpose for which the lamp was required was an important one.

The figure of 3s. 9d. per capita per year for expenditure on street lighting was not very high. The only way in which to induce municipalities to develop good street lighting was to let them have the honour of initiating something.

The paper mentioned a basis of grading streets in terms of the number of vehicles passing, but it did not state whether these figures referred to day-time or night. Some streets which had enormous vehicular traffic in the daytime had very little at night, and vice versa. He thought that there was only one correct method of grading, namely, by the amount of luminous flux put on the road, and the flux should be proportioned.

Mr. J. F. Colquhoun (Sheffield) joined with the other speakers in thanking Mr. Mackenzie. The paper had brought many happy recollections of a most notable visit to America during the meetings of the I.C.I. in 1928.

On the first page the author said that unquestionably a street-lighting system maintained under contract with a local public utility company was the most effective means of providing adequate street lighting. He thought that the general opinion in this country was that the best way of proceeding was by appointing an official directly under the local authority. He believed that results under that system had been very much better. It was remarked that improvements in municipal street-lighting systems were generally undertaken piecemeal. Unfortunately, that was frequently so in England.

Some interesting figures with regard to the lighting of streets in Chicago were given. He had been told that the installations were maintained by the shopkeepers in the streets, and he would be glad to have the information confirmed or corrected. He also understood that there were miles of streets in Chicago not lit at all. That was a state of affairs which the public in this country would hardly tolerate.

Reference had been made to the B.E.S.A. Specification (which, like King Charles's head, was difficult to get away from!) In reality this and the American code were based on distinct methods and attempted to achieve quiet different things. Undoubtedly, the advice given in the American code was good, but, whilst he appreciated the good work that had been done by the American Illuminating Engineering Society, he (Mr. Colquhoun) preferred the B.E.S.A. method, which was more explicit. For example, it prescribed what the mounting heights should be, what the distance between lamps should be, and what the degree of illumination should be. He had formed the impression that in the United States opinion was more varied on such points, and it was therefore difficult to be explicit. In this country, after a considerable amount of discussion, they had been able to arrive at definite figures, and though they represented a compromise they could be regarded as crystallizing considered opinion.

As had been said, there was great difficulty in this country with regard to highway lighting. The matter had constantly been brought to the notice of the powers-that-be, and possibly something might be done in the future. He noticed the statement in the paper, in connection with the question of lighting for street traffic control, that congestion and inadequate traffic facilities cost America over two billion dollars, or about 20 dollars per capita annually. He would be very much obliged if Mr. Mackenzie would state how the figures were arrived at. He did not see how to assess the cost of adequate traffic facilities.

On the question of electric advertising signs Mr. Mackenzie apparently considered that carefully designed and well-illuminated displays were as valuable in the daytime as at night, and did not detract from the beauty of fine architecture. Then the paper went on to speak of the "terrific" illumination derived from multitudinous electric signs. If "*terrific*" was used to mean something which filled one with terror, he entirely agreed. He had, however, seen sufficiently glaring signs in London, by which, in his opinion, the buildings were debased.

There was a good deal of gas lighting in America, and he had been somewhat surprised to find that it had been so neglected. Apparently no attempt was made to use modern methods of illumination in connection with gas. The neglect was so general that one almost received the impression that there was a definite understanding that no money should be spent on developing gas lighting. Perhaps Mr. Mackenzie could give some information on the subject.

As to methods of raising money for street lighting, many municipalities in this country had a horror of the instalment system, and, he thought, rightly. During the past six years Sheffield had erected 9,000 street lamps and installed 11,000 controllers or switches, and the money had all come out of current rates. He rather thought that the better way was for the expenses to be borne year by year by the taxes of the year.

Mr. A. Cunnington remarked that a parallel with street lighting was to be found in the lighting of railway platforms—a problem with which he had constantly to deal. Some years ago experiments were carried out on the Southern Railway on the question of the avoidance of extreme diversity in illumination. That point was brought out in the B.E.S.A. Specification and he would stress it. It was found that if only these extreme variations could be avoided one could manage with an average illumination much lower than would otherwise be needed.

Judging from some of the slides that had been shown it seemed to him that uniformity was not stressed sufficiently, and that sufficient regard was not paid to avoiding abrupt transitions in brightness and "spots" of light.

Mr. H. H. Long said that the paper was very helpful and was, he thought, the first step taken in this country towards initiating methods of getting public lighting properly valued. He thought that until a bold move was made we should always be spending the minimum amount on street lighting.

Mr. W. J. Jones said that the paper was very refreshing because of the stimulating thoughts which Mr. Mackenzie had expressed as the result of his studies. It appeared that the use of series lighting was on the increase in the United States, and he was interested to hear that. From conversations with a number of authorities in the States he gathered that if they were starting *de novo* they would use the multiple system.

He had seen some exceedingly graceful concrete pillars in America, and he had rather hoped to see something in use in this country, but he gathered that the life of such pillars was remarkably short because of the vibration (to say nothing of the effects of collisions!).

He wished to emphasize the importance of every large city having a properly qualified public lighting

engineer. Very great improvements almost invariably took place when once a public lighting engineer was appointed. This was an outstanding factor in the development of street lighting.

Mr. Mackenzie had done a good service in bringing before the meeting the question of assessing the benefits of good public lighting. Statistics on this point were very valuable but also most difficult to obtain. Every effort should be made to get such facts, so that the value of better lighting could be impressed upon municipal authorities.

Mr. W. Grant Mackenzie, in reply:—

It appears that certain gentlemen who took part in the discussion seem to have overlooked the fact that the copy of the paper they had was an *unrevised* proof. This will obviate reply to some points raised, and which were based on typographical errors.

Rotary and similar public clubs and institutions do not *assist* with street lighting. Their co-operation is secured from a " pride of city " point of view only. The mass psychology of the U.S.A. is so entirely different from that of this country, that unless one clearly understands and appreciates that difference it will be somewhat difficult to understand this enthusiasm and pride from a civic point of view. In this connection one might mention that besides the undoubted illumination value of super installations, they are, without question, an admirable form of publicity used by the more progressive cities.

The discussion on arc lamps was most interesting, but the author would point out that his paper dealt with present-day methods only, and no attention had been paid to the history or transition stages of street lighting. For this reason, only a brief reference was made to arc lamps.

The author is endeavouring to obtain information on the basis of the statistics quoted in regard to street accidents and the cost of traffic congestion, and hopes to present these data in a subsequent issue of the journal.

The question relative to Chicago installations being maintained by shopkeepers in the streets can be confirmed, inasmuch that these shopkeepers were naturally purchasers of bonds as detailed in the paper under the heading " Financial Street Lighting." In this connection the author would point out that these means, while perhaps not being the most effective, have certainly proved their worth in the States, and, on analysis, some aspects of such methods could possibly be used to advantage in this country. The author will be glad to supply a copy of a typical petition and letter used for raising a bond issue, should anyone be interested in these. Here it may be added that, in the U.S.A., progressive street lighting brings about better shop-window lighting, which, from the discussion, appears to be the opposite to the procedure in England.

In his paper the author made reference to " patchwork quilt " installations resulting from different designs and different types of equipment. Such installations will undoubtedly appear if certain sections of the street-lighting scheme are done by the expense being borne year by year by the taxes of each separate year. If efforts could be made to escape from " a horror of the instalment system," and street-lighting schemes financed by bond issues, more uniform, complete and up-to-date installations would result.

With regard to the discussion on abrupt transitions in brightness relative to highway lighting, it should be borne in mind that this question will always be a trouble until a sufficient length of highway has been taken as a unit. When this has been done it prevents cars driving from light to dark-to-light patches, and before uniform highway lighting was perfected motorists preferred to be without such lighting and rely only on the steady illumination of their own head-lights.

It must be pointed out that the author spent but 2½ years in the U.S.A., and the purpose of his paper was but to present the street-lighting facts as they exist in the States to-day. Similarly, the American street-lighting code was merely quoted by way of comparison, with the hope that this, together with other facts, might prove of interest to street-lighting engineers in this country, and from which they might derive new ideas.

It can be definitely stated that the life of hollow-spun concrete poles is anything but short, and they will withstand any vibration or collision within reason.

Space does not permit to deal with the question of multiple and series systems, but brief reference can be made to the fact that, when properly designed, the margin of advantage in the one over the other is not great under certain conditions. The series system requires a few large regulating transformers, whereas approximately twice as many of a smaller size are required for a multiple system. Due to fewer transformers, series circuits are easier to control. The multiple system also requires approximately three times as much wire as the series system, but the energy losses are about 30 per cent. less in the former. With reference to lamps, these are more efficient throughout life in the series system than the multiple, and therefore replacements costs will be lower. This comparison could be continued at length with supporting figures, and the author will be glad to do so should interest in this matter warrant the enlargement.

In conclusion, the author would express his most sincere thanks for the interest shown in his paper, and can but trust that the facts presented will possibly provide street-lighting engineers with food for thought on this subject, if not necessarily a desire to adapt or change their existing practice.

Colour Blindness and Traffic Signals

In our note on the above subject in the April number of this journal we referred to the estimate that 4 per cent. of motorists were more or less colour-blind, and hazarded the suggestion that the great majority of these suspects would have no serious difficulty in distinguishing the colours of traffic signals. We are glad to have confirmation of this in a letter from Dr. M. Luckiesh, who remarks that the same question was raised some years ago in the States. Investigations then undertaken seem to have established the fact that only a very small fraction of the 4 per cent. commonly considered to be colour-blind cannot adequately distinguish between red and green. The number was, in fact, so insignificant that any appreciable expenditure in altering existing traffic signals was unwarranted. If some supplementary distinctive device, apart from colour, is worth while, a possible method would be to arrange more than one red light in a horizontal row and more than one green light in a vertical row. Alternatively, as the full development of luminous traffic signals has only now commenced in this country, distinctive shapes (e.g., a circle, square and triangle) associated with the three colours might possibly still be adopted. However, adherence to the principle of always having the red lamp at the top and the green light at the bottom would in itself help to enable a partially colour-blind person to recognize which signal was showing.

The Art of Illumination*

III.—The Art of Lighting by Daylight

By JOHN W. T. WALSH, M.A., D.Sc., M.I.E.E.

FOR centuries past, most buildings have been designed so that work can be carried on inside them during daylight hours without the need for any artificial illuminant. To a very large extent, however, the principles of window design have been governed at least as much by other considerations (æsthetic or purely constructional) as by a desire to give adequate daylight illumination over as large a floor area as possible. The design of all parts of a building is, of course, the concern of the architect, and he is responsible that the building shall fulfil its function properly in this respect, just as much as that its appearance shall come up to the æsthetic standard demanded by those for whom it is being erected. The much greater attention that is now being paid to the provision of adequate and suitable artificial lighting has brought about a greatly increased interest in daylight. In consequence of this the provision of adequate daylight in buildings is now carefully considered, not only by architects, but also by those for whom buildings are designed.

It is not unnatural that the illuminating engineer should be expected to be in a position to help in this matter, and it is unfortunate that daylight has not, in the past, received as much attention as artificial light at the hands of lighting specialists. While this is true in general, we may, on the other hand, be proud that the scientific study of daylight has proceeded much further in this country than anywhere else in the world. There are probably two chief reasons for this. In the first place, England is not blessed with as plentiful a supply of daylight as countries in more southerly latitudes, so that it is not unnatural that less attention should have been paid to the economical use of daylight in France or in the United States of America, for example. Secondly, it so happens that this country is almost alone in having a law dealing with the obstruction of a long-enjoyed right of light by the erection of a new building near-by. The law of "ancient lights" is one which necessarily leads to a very large amount of arbitration, and even litigation, and it is not surprising, therefore, that the principles governing the provision of adequate daylight should have been studied in this country first of all.

It is useful here to digress slightly in order to describe what has proved to be a very valuable method in the study of daylight problems—viz., the use of scale models. As far as I am aware this method was first employed in this country by Mr. P. J. Waldram, and in 1913 he and Professor Clinton demonstrated the fact that if you have two structures, one of which is a reduced scale model of the other, then the daylight conditions in both will be identical if both are exposed to the same sky. The value of such a principle will be obvious at once. All architects are accustomed to employ scale models of buildings for various purposes, and to be able to study the daylight conditions in a building by the use of a comparatively inexpensive model of an appropriate scale (1 inch to the foot is often used) is an enormous advantage.

A skeleton building has been erected at the National Physical Laboratory to enable experiments to be carried out on models constructed to a larger scale. For example, work is at present proceeding on the effect of the internal decoration of a room on the illumination received at points remote from the window. This work is being carried out on a model room 9 feet wide, 9 feet high, and 18 feet deep from window to back wall. This would be described as a large-scale model.

The model on the table is a small-scale model and represents a room 12 feet high, 23 feet wide, and 32 feet deep, to a scale of $\frac{3}{4}$ inch to a foot. At the back of the room is fixed a photo-electric cell of the kind described previously. The part of the cell receiving the light is placed at a position in the room corresponding to the table height and a distance of 21 feet from the window. The window opening is 12 feet wide by 9 feet high, the window head being at ceiling level. In front of the window is an artificial sky of approximately uniform brightness. The amount of light reaching the point at which the photo-electric cell is placed is indicated by the deflection of the galvanometer spot. *(The lecturer here gave a demonstration by covering portions of the window space in the model.)* We will first study the effect of raising the height of the window-sill by 2 feet. Next we will restore the sill to table height and bring the window head down by 1 foot. You will see at once that a loss of 1 foot at the top is very much more serious than a loss of 2 feet at the bottom of the window as far as the lighting at the back of the room is concerned. This effect is even more pronounced in the case of a window having an obstructed outlook (as is the case of most actual windows, at any rate on the lower floors of buildings). If we erect a building on the opposite side of the road, equal in height to the room we are considering, and then perform the same experiment as before, we shall find that a loss of 2 feet at the bottom of the window produces very little result at all at the back of the room. The loss of 1 foot at the top, however, is almost as serious as it was before. Since the illumination from the whole window is now less, this means that the percentage loss of light due to lowering of the window-head is much *more* serious than in the case of an unobstructed window. The heavy stone bars not infrequently to be found in the upper halves of the windows of buildings of a certain period are generally unnecessary from a structural point of view. In many cases they can be removed without much consequential alteration to the walls, and their removal effects a very remarkable improvement in the illumination conditions in the room. This is but one example of the way in which the architect can, by his window design, profoundly affect the utility of a room as far as its use during daylight hours is concerned.

The effect of an external obstruction on the efficiency of a window of given size and position has already been demonstrated, and it is, of course, self-evident that the amount of this effect will increase with the height of the obstruction and its proximity to the window. These two factors can be combined by saying that the effect of an obstruction is governed by the angle of elevation of the top of the obstruction as measured from the *head* of the obstructed window. The angle of elevation of the obstruction has, in the past, frequently been measured from the window-*sill*, but a moment's consideration will show that this is illogical. The boundary line of that portion of the room from which no sky whatever can be seen is, clearly,

* Delivered February 3rd, 1931. Abstract of the second of a series of three lectures before the Royal Institution. (The first lecture of the series was reported in *The Illuminating Engineer* for May, 1931, pp. 111-114.)

defined by drawing lines from the top of the obstruction to the head of the window and then continuing these lines until they cut the working plane of the room. The position of this boundary line (often called the "no-sky" line) is often used to give an idea of the excellence or otherwise of the daylight conditions in a room. If the "no-sky" line is near the window the window is badly obstructed and the room is ill-provided with daylight. On the contrary, a "no-sky" line close to the back wall of the room indicates a high standard of daylight illumination.

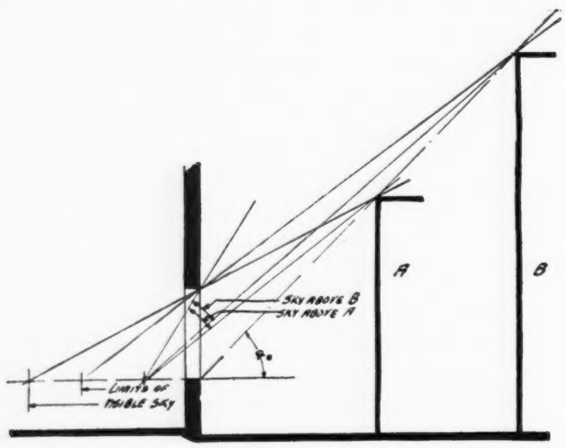


FIG. 1.—Construction for finding the "no-sky" line in a room.

The above statements cannot, of course, be taken without reservation or qualification. A more strictly logical criterion of the daylight standard is provided by a plan of the room on which contours of equal daylight-factor have been drawn. Such a plan is shown in Fig. 2. The line marked "0.5" indicates, for example, that at every point on that line the daylight factor is 0.5 per cent. In other words, all parts of the room behind that line have an illumination which is less than 5 thousandths of the illumination at any point on the roof of the building. Similarly, all points on the window side of this line enjoy more than 5 thousandths of this illumination. Contour lines have been drawn on the plans for daylight factors of 1, 0.5, and 0.2 per cent.

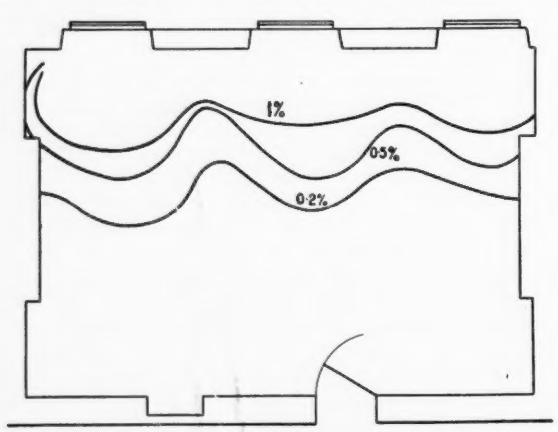


FIG. 2.—Daylight-factor contours in a room.

There is at present no generally recognized standard of daylight efficiency for rooms, but there seems to be a consensus of opinion that a daylight factor of 0.2 per cent. is the border-line at which the daylight provided ceases to be considered adequate by reasonable users. This opinion has been endorsed in legal decisions in ancient-light cases, and attempts are to be made to obtain international agreement on the subject at the meetings of the International Commission on Illumination this year. If this figure be accepted, it implies that the 0.2 contour line divides the working plane of the room into two portions, one adequately and the other inadequately provided with daylight. The only matter that remains to be settled is the fraction of the total area which must lie on the right side of this contour before a room can be regarded as adequately lighted by day. As to this there is no general agreement at present. It is one of the urgent matters that must be settled after careful consideration by architects and others responsible for the development of sites and the erection of buildings.

We now come to the consideration of a specially difficult problem in daylight planning. When a building has to be erected on a site of considerable area it becomes necessary to provide light-wells, so that the rooms which cannot be given an outlook on to the boundaries of the site may receive sufficient daylight for ordinary purposes.

There are several ways in which the building may be planned to occupy any given site. The conventional plan is that shown in Fig. 3.* A more unusual plan is shown in Fig. 4. This includes what

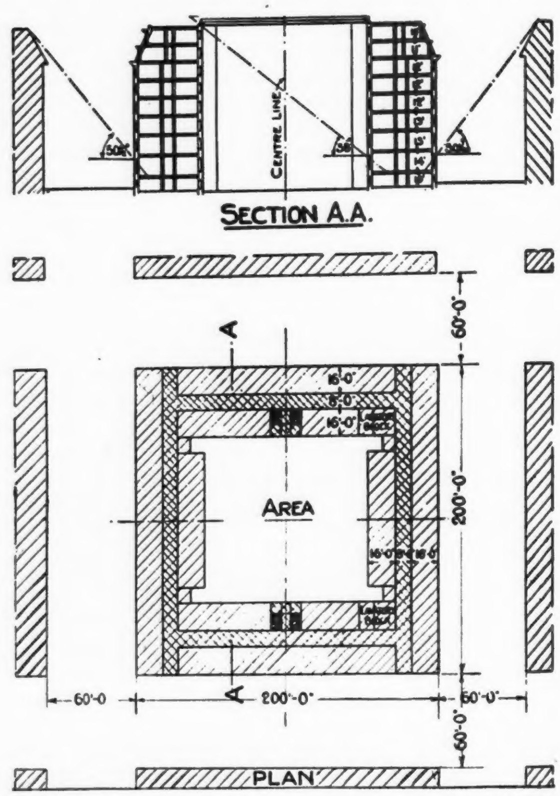


FIG. 3.—Development of an island site using a central light-well.

are often referred to as "external light-wells." Still a third plan is that shown in Fig. 5. The three methods naturally give different total floor areas available for use as office accommodation. The first plan provides the greatest area, but, on the other hand, the third plan gives considerably better-lighted rooms.

Until quite recently there has been very little accurate information available as to the amount of light reaching the walls at given depths in a light-well of specified dimensions and coated internally with a surface of a given reflection factor. This is clearly a problem which can be conveniently studied by the model method, and a careful investigation has been carried out and the results published within the last few months.

* This figure and Figs. 4 and 5 are taken from a paper by Mr. J. G. West in the *Proceedings of the International Commission on Illumination*, 1928, p. 492.

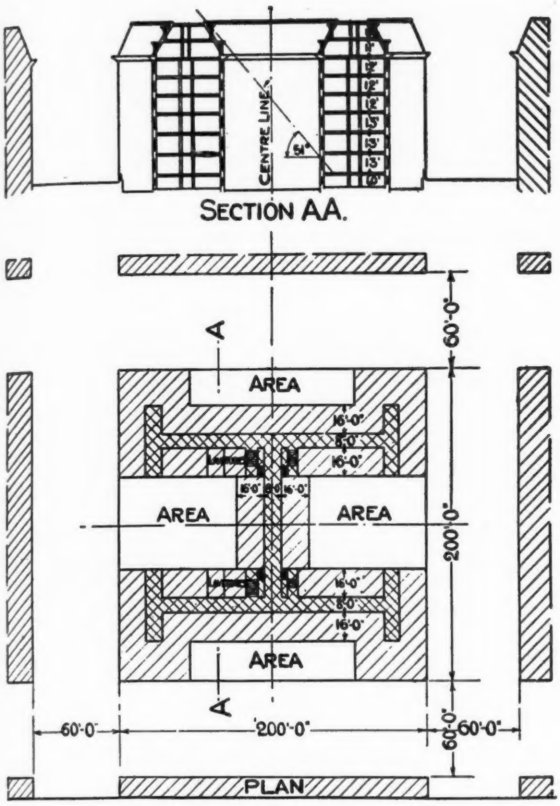


FIG. 4.—Building with external light-wells.

It is now possible for the architect to calculate with a considerable degree of precision how much light will be available for the windows of lower floor rooms the only outlook of which is on to a light well of given dimensions.

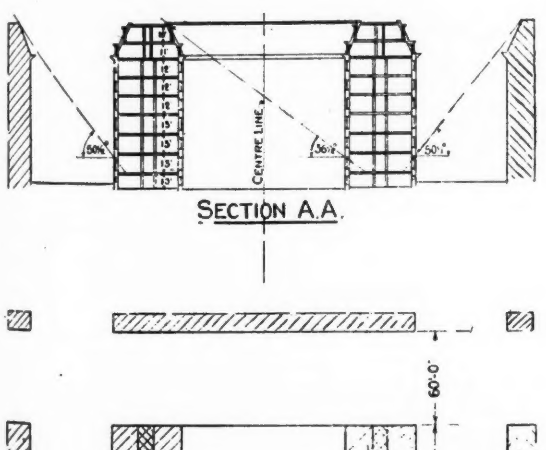


FIG. 5.—Building designed for specially good daylight conditions.

There are, of course, several matters, other than those just described, which affect the amount of light entering a room. One of these is the kind of glass used in the windows. Ordinary plate or window glass does not vary much in its transmitting qualities. On the other hand, the different types of diffusing or obscured glasses have very various transmission factors. Some, too, are more difficult to clean efficiently and so show a more rapid deterioration due to dirt accumulation.

Where a window is much obscured two devices may be used to increase the illumination in the room. One of these is the plane mirror reflector, supported at an angle outside the window so as to reflect light directly from the sky through the window. The other device frequently used in the lower floor windows facing a light-well is prismatic glass of some form. The surface of this glass consists of a large number of horizontal prismatic elements, the angles of the prisms being such that light reaching the external surface of the glass obliquely is deflected towards the horizontal. In this way, light that would ordinarily reach the working plane close to the window is thrown inwards towards the back of the room, and a greater area of the working plane is rendered useful during daylight hours.

In the case of deep rooms, the tone of the internal decoration has a great influence on the amount of light reaching the back of the room. This can be very clearly demonstrated by means of the model which we used before. If we substitute for the original pale cream-coloured walls and ceilings others of a dark grey colour, the illumination at the back of the room is reduced to less than one-half of its former value. (*This was shown by means of the model and photo-electric cell used previously.*)

Last week we mentioned the artificial lighting of picture galleries as a specially difficult problem for the illuminating engineer. The provision of suitable daylight illumination for these buildings is at least equally difficult and for the same reason—viz., the fact that the glazing of the pictures gives rise to annoying reflections either of the windows themselves, of the pictures on the opposite wall, or of the spectators.

The conventional method of lighting a picture gallery is to provide a large roof window extending for the whole length of the room and occupying either the central part of an arched roof, or a portion of each side of a pitched roof. In either case it is possible, by proper design, to avoid all reflections of the windows in the glass of the pictures so long as these are not hung at too great a height. It is quite otherwise with reflections of the spectators, however. This form of roof-lighting gives a maximum illumination on objects in the centre of the room, and the illumination of the picture-wall is, if anything, less than that of the face of a spectator viewing the pictures. Now, picture glass gives a reflection the brightness of which is about 9 per cent. of that of the object reflected. It follows that in the ordinary picture gallery the spectator sees a reflection of himself in the glass of the picture he is looking at, and this reflection may well be brighter than the picture itself, if the latter be dark in tone. In fact, it is very easy to use some of the darker pictures in our national galleries as mirrors by which to effect a re-adjustment of one's tie or to secure a brooch which has become unfastened. To the serious visitor, however, these reflections can be most annoying, and the only way in which they can be avoided is by so designing the gallery that the illumination of the picture-wall is much higher than that of the spectators. This solution has been attempted along different lines for a considerable time past.

A very effective design has, however, been adopted for one of the smaller rooms in the Duveen wing at the National Gallery, Millbank (Tate Gallery). The section of this room is shown in Fig. 6. The design was originally prepared by the architects, Messrs. Romaine Walker and Jenkins, and a small-scale model was then constructed. As a result

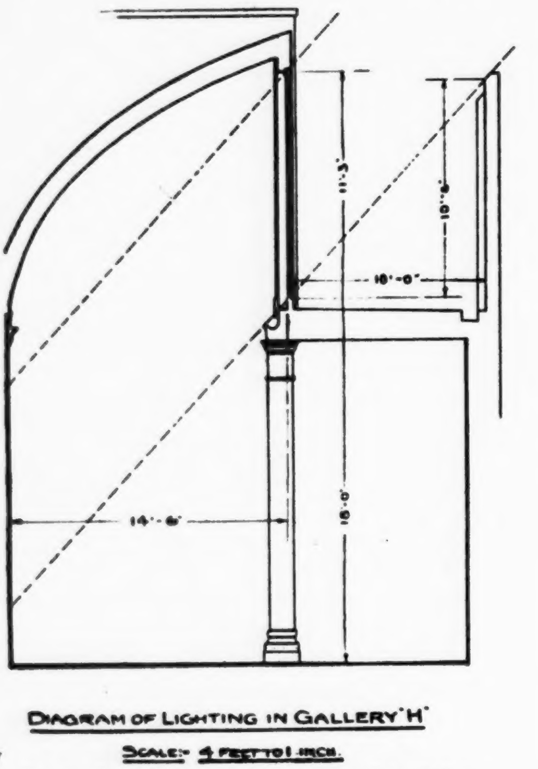


FIG. 6.—Section of Room XIII at the Tate Gallery.

of the measurements made on this model, the proposed dimensions were slightly modified and the room was then erected to this modified design. The spectators normally remain within the portion of the gallery below the flat roof, where they are in comparative darkness. The picture-wall, on the other hand, receives an ample illumination. The result is a complete elimination of reflections in the glazing, even for the darkest-toned pictures. In fact, shortly after the gallery had been erected some unglazed pictures were hung among others that were glazed, and it was found quite impossible to distinguish between the two except by approaching the picture-wall quite closely. There is, of course, a certain loss of useful area owing to the fact that there is only one picture-wall. As, however, the width of the gallery is only two-thirds of that of the usual centrally-lighted gallery with two picture-walls, the loss of space in the new design is only 30 per cent. The room I have just described is Room No. XIII at the Tate Gallery, and it will well repay a visit from anyone interested in the subject of picture gallery design.

Another interesting example of the difficulties met with in lighting picture galleries has recently occurred at the National Portrait Gallery.*

Another problem in picture gallery lighting—and it applies equally to museums—is the prevention, or at least the reduction, of fading due to the exposure of the pictures or coloured specimens to ordinary daylight. Water-colour pictures are, of course, notoriously subject to fading, and there is little doubt that many of the Turner water-colours in the National Gallery have suffered a considerable degree of deterioration in spite of all efforts to preserve them in their original condition. The problem is a very complicated one, as it is now clear that the rate of fading is greatly affected by the humidity as well as by the illumination. For many years it was thought that the ultra-violet part of the spectrum was that chiefly responsible for the fading, and it was for this reason that the Raphael Cartoon Gallery at the Victoria and Albert Museum was roofed with a patchwork of green and orange coloured glasses, so proportioned that the mixed light transmitted was sensibly white to the eye. The ultra-violet portion was certainly suppressed, but at the same time the total light was greatly diminished. Special glasses are now made to cut out the ultra-violet light. Such glasses show a very slight coloration, but this is not sufficiently pronounced to spoil the colour values of the pictures. Unfortunately, it has been found that some of the visible part of the spectrum is also potent in producing fading, and, as it is clearly impossible to eliminate this without an intolerable colour distortion, the only line of attack on this problem seems to be to place all fugitive pictures and specimens in cases which can be kept absolutely dry.

Quite opposite in character to the problem just mentioned is that of admitting to a room the whole of the available light, especially in the short-wave region of the spectrum, so that the health-giving effects of the therapeutic band of wave-lengths may be obtained by the occupants of a room. The use of ultra-violet transmitting glass is now quite common even in ordinary dwelling-houses. There is, unfortunately, one drawback to this glass. Continued exposure to light causes what is known as "solarization"—i.e., the power of the glass to transmit the ultra-violet rays becomes less. This effect can, however, be greatly reduced in amount by eliminating all iron contamination in the manufacture of glass.

The benefits which can be derived from the use of glass of this kind have been much discussed. A recent authoritative report sums matters up as follows:—

"In buildings other than those designed specifically for sun treatment, although ultra-violet glass in large, unobstructed windows can admit the therapeutic radiation in appreciable quantity, to receive this radiation it is essential to sit near a window or in the direct rays of the sun."

This concludes our consideration of the subject of daylight. We have, during the past three weeks, studied the vast improvements which have been made in light sources and lighting appliances. We have seen that lighting has now ceased to be a branch of engineering pure and simple, and that it is rightly taking its place among the useful arts. Progress is now very rapid, and there is no doubt that the next ten years will see surprising developments and most remarkable progress in this young art, the art of illumination.

The Retirement of Sir Francis Goodenough

We observe with interest the announcement of the prospective retirement of Sir Francis Goodenough from the Gas Light and Coke Company. The forty-three years of service that Sir Francis has given to the company have indeed been arduous, and he has been much occupied with other interests. We understand, however, that the gas industry will continue to benefit from Sir Francis's experience. Readers will recall that Sir Francis is the President-elect of the Illuminating Engineering Society, in which he has taken a keen interest from its very early years, and will enter upon his period of office in October next.

* See paper by Mr. J. Macintyre before the Illuminating Engineering Society. *Illum. Eng.*, Dec., 1930, p. 291.

Literature on Lighting

(Abstracts of recent articles on Illumination and Photometry in the Technical Press)

(*Continued from page* 116, *May*, 1931)

Abstracts are classified under the following headings: I, Radiation and General Physics; II, Photometry; III, Sources of Light; IV, Lighting Equipment; V, Applications of Light; VI, Miscellaneous. The following, whose initials appear under the items for which they were responsible, have already assisted in the compilation of abstracts: Miss E. S. Barclay Smith, Mr. W. Barnett, Mr. S. S. Beggs, Mr. F. J. C. Brookes, Mr. H. Buckley, Mr. H. M. Cotteril, Mr. J. S. Dow, Dr. S. English, Dr. T. H. Harrison, Mr. C. A. Morton, Mr. G. S. Robinson, Mr. W. C. M. Whittle and Mr. G. H. Wilson. Abstracts cover the month preceding the date of publication. When desired by readers we will gladly endeavour to obtain copies of journals containing any articles abstracted and will supply them at cost.—ED.

I.—RADIATION AND GENERAL PHYSICS.

77. Absorption and Scattering of Light in Opal Glasses. G. M. Dreosti.

Phil. Mag., 11, *p.* 802, 1931.

The paper expands Schuster's theory of scattering to the case of thick layers in which large particles are embedded. The paper is largely mathematical. H. B.

78. Filters for the Reproduction of Sunlight and Daylight and the Determination of Colour Temperature. Raymond Davis and K. S. Gibson.

Bureau of Standards, Miscellaneous Publication, No. 114, *January*, 1931.

A large number of liquid filters for use in photographic sensitometry, colorimetry and photometry are described. They are reproducible from specification, and consist of 2-compartment cells with three borosilicate crown glass windows, the compartments being filled with solutions A and B. Series A contains variable amounts of copper sulphate, and series B variable amounts of copper sulphate and cobalt ammonium sulphate.

H. B.

II.—PHOTOMETRY.

The following abstracts (Nos. 79-86) deal with the *Report of the National Physical Laboratory for the year* 1930, which contains an informative survey of photometry. There are sections dealing with:

79. Photo-electric Photometry. (Page 145.)

Reference is made to an Electrometer Photo-electric Photometer for use in the measurement of both directional and mean spherical candle-power. Other apparatus referred to under this heading are Thermionic Bridge Photometer, Photo-electric Daylight Recorder, Photo-electric Apparatus for the measurement of Sub-aqueous Illumination, and New Photo-electric Cells. W. B.

80. Heterochromatic Photometry.

A New Spectrophotometer. The apparatus described in the report for 1929 has been improved, and reference is made to the agreement between the experimentally deduced and calculated calibration. Other subjects dealt with under this heading (page 146) are: The Transmission of the Ives Y/B Solutions; Transmission of Coloured Glasses; The Validity of Flicker Photometry with Large Colour Differences; The Determination of the Transmission Factors of Coloured Lenses; The Effect of Temperature on the Red Glasses used in Optical Pyrometers; The Experimental Determination of Mean Effective Wave-length in Optical Pyrometry; The Inter-Reflection of Radiation. W. B.

81. Photometric Standards. (Page 147.)

Reference is made to work prepared and in progress to investigate the practicability of using a black body radiator, maintained at the freezing point of platinum, as a primary standard of light.

W. B.

82. International Comparison of Photometric Standards. (Page 148.)

Reference is made to an inter-comparison of values of candle-power standards at carbon filament colour, between the N.P.L. and the Bureau of Standards, Washington, and to a comparison initiated by the Nela Research Laboratories of the General Electric Company of America, of values of lumen output—for tungsten filament lamps of various types—obtained at a number of national and other research laboratories throughout the world. W. B.

83. Gas-filled Sub-standard Lamps.

Specially constructed gas-filled lamps are being prepared for use as sub-standards in the measurement of luminous flux. These lamps are rated at about 110 volts, 100 watts, at an operating efficiency of 10.5 lumens per watt. Similar lamps are available for supply to clients. W. B.

84. International Comparison of the Transmission of Four Blue Glasses. (Page 149.)

Details are given of an inter-comparison of the transmission of four blue glasses which have been measured at four national laboratories, using in each case—(1) A Spectrophotometer, (2) Lummer Brodhun Photometer, (3) Flicker Photometer.

W. B.

85. Measurement of Brightness of Radioactive Luminous Compounds. (Pages 150-152.)

Two instruments are described, accompanied by diagrammatic sketches, for use in the measurement of the brightness of radium luminous compound, one for large surfaces and the other—employing Maxwellian view—for use in the measurement of smaller surfaces, such as those used in luminous prism foresights. W. B.

86. Mechanical Integrator for the Determination of Daylight Factors. (Pages 154-155.)

An instrument has been devised for measuring the illumination of a horizontal surface at any point in the interior of a building due to the daylight received there from windows in the walls or roof. The description of the instrument is accompanied by two illustrations.

Other subjects referred to in the section on illumination are: Skylight Illumination: Daylight Factors in Deep Rooms: Photometric Test Plates: Lamps for Illumination Photometers: Precision of Portable Photometers; and the Protection of Water-colour Pigments from Fading.

W. B.

III.—SOURCES OF LIGHT.

87. Mass Production of Incandescent Electric Lamps. G. Chelioti.

G.E.C. Journal, 2, *p.* 35.

Second and concluding instalment giving general operation of factory with details of building and supplies. C. A. M.

88. Discharge Tubes and their Technical Application. N. L. Harris and H. G. Jenkins.

G.E.C. Journal, 2, *pp.* 4-15, *May*, 1931.

The authors give an historical account of the development and then discuss in detail the physics of the phenomena of discharge tubes. Mention is made of a new continuous animated ripple effect produced in certain conditions in a discharge tube by the insertion and replenishment of a trace of impurity in the form of another gas. C. A. M.

IV.—LIGHTING EQUIPMENT.

89. Glass or Metal?—The Trend of Lighting Fitting Design. Anon.

El. Rev., 108, *pp.* 662-663, *April 17th*, 1931.

Traces the trend of lighting fitting design from the days of oil lamps. It is stated that the present trend is for the re-introduction of metal carefully combined with glass. Photographs are shown.

G. S. R.

V.—APPLICATIONS OF LIGHT.

90. Interim Report: Committee on Light in Architecture and Decorating. Anon.

Am. Illum. Eng. Soc., Trans., 26, *pp.* 329-330, *April*, 1931.

Gives some views on the new lighting tendencies from a manufacturer of illuminating equipment. Illustrated descriptions of eight lighting installations are also given. G. H. W.

91. Lighting of Severance Hall. D. H. Holden.

Am. Illum. Eng. Soc., Trans., 26, *pp.* 331-349, *April*, 1931.

The paper describes proposed scheme of illumination, both stage and auditorium, with particular reference to a new system of lighting control incorporating preset, proportional, remote control of intensity and interconnection of circuits.

Author (G. H. W.).

92. The Architectural Approach in the Lighting of Severance Hall. C. W. Stedman.

Am. Illum. Eng. Soc., Trans., 26, *pp.* 351-359, *April*, 1931.

The author presents an analysis of the problem which confronted the architects and engineers when Severance Hall was first conceived. He proceeds with a description of ways and means employed in solving the many problems encountered in evolving the ground plan and mass of the structure, of the lighting scheme of audience hall and platform, and of the development of the so-called lighting consolem, as well as the switching and dimming apparatus which this console remotely controls.

Author (G. H. W.)

93. Lighting Transformer Stations. H. E. Hutter.

El. Rev., 108, *pp.* 701-702, *April 24th*, 1931.

The article explains briefly two types of refractors for giving the wide horizontal light distribution which is required for such positions. The lighting should be from overhead, and for upward lighting the lanterns may be inverted. 300 watts will satisfactorily light /30 ft. squared. Diagrams of equipment are shown, and the author asserts the importance of regular maintenance. G. S. R.

94. Industrial Building Design Features Good Lighting. B. W. Bernstein.

El. World, 97, *pp.* 686-690, *April 11th*, 1931.

Describes in detail the lighting of the new Middle-West plant and executive offices of the Jewel Tea Company. 500 k.w. of lighting is available.

W. C. M. W.

95. Light Beams Operate Traffic Signals. R. C. Hitchcock.

Am. I.E.E. Journal, 50, *pp.* 182-185, *March*, 1931.

A system of traffic control is described which uses a photocell unit in conjunction with a light beam directed across the road, which must be intercepted by the vehicle. This arrangement is suitable for use where a minor road crosses a main road, where the diversity of traffic either way may amount to up to 50 to 1. G. S. R.

VI.—MISCELLANEOUS.

96. Fundamental Research on Glare and Visual Capacities.

National Physical Laboratory: Annual Report, pp. 152-154, 1931.

Work under the guidance of the Illumination Research Committee has been carried out on an apparatus, described in the Report for 1929, for the measurement of the brightness difference threshold under different conditions of illumination, both for white and for coloured light. The latter has been produced by the use of a series of seven liquid colour filters in glass cells. These filters cover the whole visible spectrum. The brightness of the coloured field is measured with an illuminometer which has been fitted with a flicker photometer head.

An apparatus is described, accompanied by a diagrammatic sketch, for the determination of the glare effect in any actual lighting system. Other topics dealt with include: Illumination of Light-Wells; Diffusing Glassware; and Dock Lighting.

W. B.

97. The Appraisal of Glare. M. Luckeish.

El. World, 97, *p.* 690, *April 11th*, 1931.

Gives methods of appraisal of the defects of glare in terms of discomfort and of reduced visibility respectively. Results are given of a test by the former method. W. C. M. W.

98. A Report on Relations with Architects.

Am. Illum. Eng Soc. Trans., 26, *pp.* 360-375, *April*, 1931.

The report deals with the relations between central-station illuminating engineers and architects. Recommendations are made concerning the establishment of an advisory service to architects and consulting engineers. Author (G. H. W.).

99. The Function of the Consulting Engineer in the Field of Illumination. M. Freund.

Am. Illum. Eng. Soc. Trans., 26, *pp.* 376-383, *April*, 1931.

The author introduces his paper with a definition of the function of a consulting engineer and proceeds with a discussion of the services rendered by those consulting engineers who engage in strictly professional practice in designing the mechanical and electrical equipment of buildings and groups of buildings. Author (G. H. W.).

POPULAR & TRADE SECTION

COMPRISING

Installation Topics—Hygiene and Safety—Data for Contractors—Hints to Consumers

(The matter in this section does not form part of the official Transactions of the Illuminating Engineering Society and is based on outside contributions.)

The Floodlighting of Rochester Castle

In our last number we referred to the mild controversy which occurred recently regarding the floodlighting of historic buildings. On this page we reproduce a photograph showing the floodlighting of Rochester Castle, and leave readers to form their own opinion concerning this particular building.

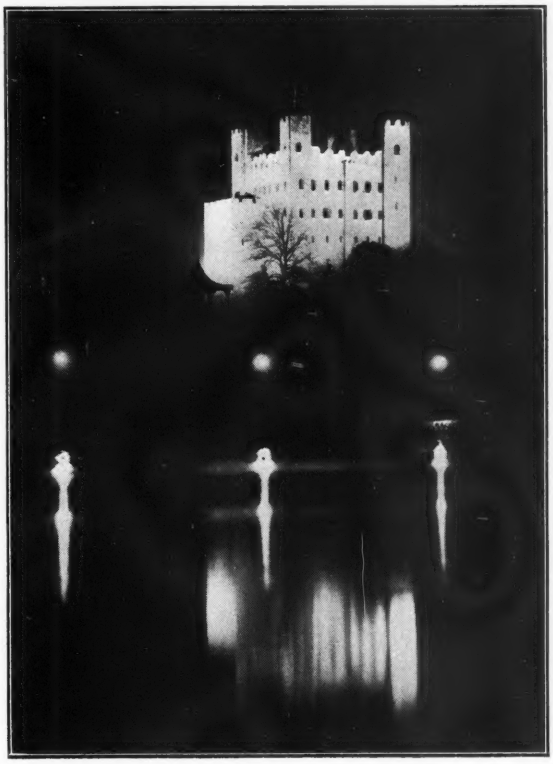
Rochester is holding a Civic Week Celebration and Historical Pageant during this month, and overseas visitors are expected to be present in large numbers for the purpose of visiting the ancient castle.

This fine old building, occupying a commanding position, can be seen from the main road, the railway, the coast and the river for a distance of several miles, and in connection with the above-mentioned festivities it was decided to floodlight it in order to give it prominence after sundown.

The planning of the floodlighting was entrusted to the Illuminating Engineering Department of the Edison-Swan Electric Co. Ltd., and, as will be seen from the photograph, their efforts have been most successful. The view from across the Medway is delightful.

The equipment employed consists of Ediswan "Mars" projectors with 1,000-watt Royal Ediswan lamps so arranged that an effect is obtained similar to, and in some respects better than, the general daylight appearance of the castle. The floodlighting, in fact, actually emphasizes details which are not so apparent in daylight.

The installation was carried out by The Kent Electric Power Co., of Rochester.



A Pleasing Night Picture: The Floodlighting of Rochester Castle.

Indoor Cricket Schools and Artificial Lighting

Indoor cricket schools are becoming increasingly popular. There has been much speculation on the best form of wicket—concrete and matting on a surface of marl both have their advocates. But surely an all-important matter, if practice in the evening is to be encouraged, is the artificial lighting. This ought to be a simple matter if those interested would bear in mind the desirability of sufficiently diffused and strong illumination, coupled with the *complete* removal of sources of artificial light from the range of view. It is singular that otherwise discriminating people frequently do not realize the inconvenience imposed by the fact of a light being visible, even though it is only seen "out of the tail of the eye." If a source of materially greater brightness than its surroundings is visible at all, it is sure to cause some disturbance of vision, especially in cases where decisions must be taken in a fraction of a second. The third point we should like to emphasize is the vital importance of background. The light-coloured and evenly bright background provided on first-class cricket grounds should be available during practice.

A Planetarium for London

It is some years since the suggestion that London ought to have at its disposal a "planetarium"—the wonderful device developed in Germany for illustrating the motions of the heavenly bodies. The planetarium has proved a popular and profitable source of entertainment abroad, and no doubt the authorities at South Kensington will recover in due course the cost of erection. As a spectacle, the display within the planetarium is entrancing, as (to quote a writer in the daily press) "the stars in their courses wheel slowly before one's astonished gaze." But the expenditure on the planetarium will only be fully justified if the arousing of wonder and curiosity is made the prelude to instruction. Astronomy, however, has always been a fascinating subject, and one that appeals to the popular imagination. He would surely be a dull lecturer who could not make his subject interesting with the planetarium to illustrate his discourse!

The Lighting of the Electrical Exhibition in Copenhagen

By Dr. G. SCHMIDT

A FEATURE of the electrical exhibition, recently arranged by the central stations and the electrical industry in the "Tivoli," Copenhagen, was the special festival illumination. Some very interesting lighting devices were on view. In what follows a brief account of these is given. The rear side of the main entrance, above both gates, was vertically wainscotted with white-painted wooden boards arranged in a zig-zag manner and floodlighted by four projectors of 750 watts each, two to the right and two to the left above the entrance. By illuminating this zig-zag structure from both sides with different-coloured light, alternative boards appeared in different colours; very striking effects were achieved, especially as the coloured filters used were automatically switched on and off at certain predetermined intervals. The connected value of the total installation of the main entrance amounted to 11.3 kw.

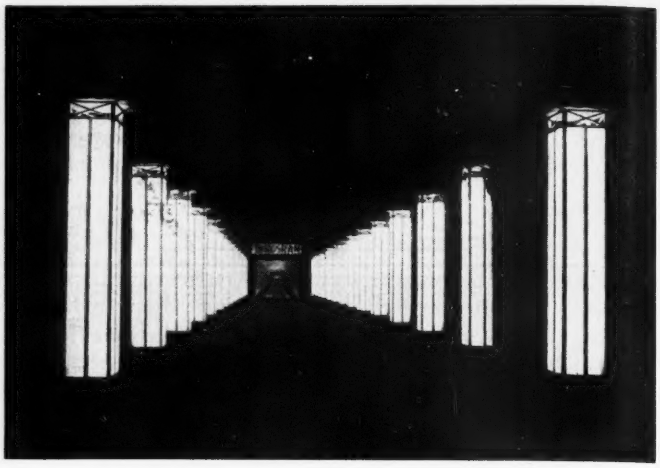


FIG. 1.—An Alley lined on either side by illuminated pillars.

Behind the entrance an illuminated assembly of flowers (6.8 kw.) and an alley of luminous pillars marked the way to the main exhibition. Each pillar was of square cross-section, 35 cm. (14 ins.) wide and 2.75 m. (9 ft.) high. The light wooden framework of the pillars was covered with white cloth, especially treated to make it sufficiently transparent, whilst the outer longitudinal edges, as well as a stripe in the middle of each pillar, were painted green. Each pillar was lighted up from within by seven lamps of 100 watts each, so that the 28 obelisks of light carried a total load of 19.6 kw. (Fig. 1.).

A new and very unique form of outdoor illumination was shown in the "Wall of Light," 250 m. (820 ft.) long, and up to 3 m. (10 ft.) high (Fig. 2).

FIG. 2.—The "Wall of Light."

At eye-level, suspended 30 cm. (1 ft.) from the wall, a flat, V-shaped wooden trough was mounted with its open side facing the wall. The reflecting inner surface of the black trough was painted white. Four lamps of 40 watts per metre run were installed in the trough, illuminating a horizontal band of a light-yellow colour, about 1 m. (3 ft.) high. On the upper and lower sides of this band, black stripes were cut into the wooden wall for the purpose of increasing the contrast. The colour of the remaining part of the wall, above and below the band, gradually changed over at the upper and lower edges to a dark yellow. The "Wall of Light" required 1,000 lamps, with an approximate load of 40 kw.

An iron structure used for travelling vaudeville shows had been converted into a "Temple of Light," mainly by the aid of indirect lighting. The total load here amounted to 56.6 kw., including stage lighting. The largest illuminated sign at the exhibition contained 1,422 lamps, with a total consumption of 43.5 kw. It was located on the Pavilion of the Osram A.S.-Copenhagen, where, besides demonstrations of lamps, there were many special exhibits illustrating the advantages of adequate and even illumination in the home, show window, store and workshop. Among the electrical exhibits, an "electrical house," erected by the Great-Copenhagen Central Station, was to be seen, as well as a house built for the exhibition by the Electrical Contractors' Union. Luminous signs were employed in great number and variety. The interior lighting also revealed features of considerable novelty. This first electrical exhibition in Denmark was, in fact, a very well-organized and effective display, which proved to be of considerable interest to lighting experts at home and abroad.

The "Scialyscope"

By the courtesy of Col. G. Davidson the writer has been given a description of the above remarkable device. At present it is not available in any London hospital—yet one understands that it is in use in Uruguay and Algiers!

Briefly, the "Scialyscope" is a combination of a special operating table lighting unit and an epidiascope. The lighting unit resembles the familiar "Scialytic" unit in design, but employs a 4 kw. lamp and a hood 7 ft. 8 ins. in diameter. The "shadowless" nature of the light emitted downwards makes it possible to introduce a conical tube which emerges sideways from the base of the lighting unit, where a lens forming an image of the area of the body operated on is formed. This image which has a magnification of three times actual size, is projected optically to a room adjacent to the operating theatre.

The possibilities of this device are evident. In the ordinary hospital theatre only a few students can get a close view of the operation. But the magnified and projected image shows all details and can be viewed by a considerable number of students, who thus witness the operation from beginning to end.

The Floodlighting of Big Ben Clock Tower

In referring to this interesting experimental installation in our last issue, it is possible that we did not emphasize sufficiently one feature—the use of supplementary local lighting to overcome inconvenient shadows. We may recall that the floodlighting of the tower was effected by 12 Holophane-Siemens long-range double-parabolic floodlighting projectors, each equipped with a 1,000-watt Siemens projector lamp. Further, a colour contrast between the clock face and the surrounding stonework was obtained by substituting Siemens 150-watt amber-sprayed gasfilled lamps for the interior lighting of the clock face, so that the latter assumes a golden hue. But a special difficulty arose owing to the fact that above the clock face section the belfry is set back, so that the project or beams cause deep shadows on the collonade arches. It was therefore decided to install a number of Siemens concentrating silvered reflectors with 100-watt Pearl gasfilled lamps directed upwards to provide local lighting. This special arrangement, which involved careful adjustment and some degree of skill, appears to have proved quite successful—an interesting instance of local lighting as an aid to floodlighting.

Recent Progress in Gas Lighting and Its Future Possibilities*

By J. G. CLARK

THE present time is a suitable occasion for making a general review of gas lighting, owing to the fact that next September the International Illumination Congress will be held in this country. It is worthy of note that this great international movement is the direct outcome of the activities of the gas industry. It was at the Paris Exhibition in 1900 that the gas conference held in that year inaugurated what has since become the International Illumination Commission, to which the art of photometry owes much.

Amongst originators of new things might be mentioned Methven, Sugg, Letherby, Evans, Harcourt, Wright and Simmance, to name only a few. The Harcourt 10-candle lamp, for example, still forms a reliable primary standard to which all secondary working standards may be referred. While it is true that gas lighting is being challenged by its competitors, it is true also that gas in this country is still the major means of providing artificial lighting, and that competition is no new thing.

Advantages of Gas Lighting.

It was gratifying to note the marked signs of revival in the matter of gas lighting in this country. No efforts should be spared to maintain existing gas lighting and to see that gas is given full consideration in connection with new housing schemes. Relative costs do not count quite so much as they did a generation ago. People are more inclined to study convenience and fashion, hence other reasons should be urged in favour of gas lighting.

The following points may be urged: —

(*a*) The light emitted from an incandescent mantle has been recently described by Sir Leonard Hill as singularly suited to the human organism.

(*b*) Gas lighting is accompanied by a certain amount of warmth. The radiant efficiency of an inverted incandescent burner measured thermally is about 30 per cent., so that it can contribute substantially to the comfort of the person using the light. In 99 times out of 100 this warmth is a distinct advantage, and its absence would involve some supplementary source of heat to maintain comfortable conditions.

(*c*) The diffusion arising from the relatively low intrinsic brilliancy of an incandescent mantle, whether diffusing glassware is used or no, is an advantage. This low brilliancy has some relation to glare, particularly in connection with street lighting and is undoubtedly in favour of gas.

(*d*) Fog penetration of street lamps is an important factor. Although no information that might be called scientific is available in support of the advantage of incandescent gas lighting from this standpoint, any policeman will support this view. Attempts were made last winter to examine this problem at Watson House, but unforeseen difficulties were encountered and, as fogs cannot be made to order, the work has still to be completed.

(*e*) Great progress has recently been made in the control of gas-lighting units. There are several varieties of clock control for street lighting. Large groups of lamps, such as shop lamps, lamps in lecture halls, etc., can be controlled from one point. The Newbridge switch for the control of domestic burners has proved most successful in practice.

Burner Design.

It seems sometimes that the art of producing light has outrun the art of applying it. Artificial light is already a cheap commodity—probably one of the cheapest known, bearing in mind its value to society. If it were ten times as expensive it might be more wisely applied.

Many years ago attention was drawn to the cheap and inefficient burners and mantles being offered to the public through retail shops. Since then really good but cheap burners have been put upon the market. Nevertheless, manufacturers do not always realize the importance of accuracy. The injector orifices, for instance, should not be so large as to need the use of a regulator to adjust the consumption to the right amount. Gas regulators will no doubt soon be things of the past. Many burners are still made with reciprocating pins, but these are intended to assist the removal from the injector of foreign matter that may interfere with the flow of gas. Trouble may arise through the injector being ragged owing to careless drilling. This can be easily avoided by supervision at the works. It is a matter of opinion whether one or several orifices should be used. A practically silent burner can be made with a single orifice, and as this is less subject to interference from dust the method has advantages. Governing in relation to gas lighting also deserves careful study, especially where the difference between good and bad lighting may make a substantial difference to output and performance of work.

Cluster Burners.

A striking development has been the widespread development of the cluster burner, which enables high candle-power sources to be obtained without any increase in intrinsic brilliancy. The method also enables gas to be used at ordinary pressures, and the facility for grouping mantles in various ways has encouraged its extension. It should be noted, however, that as the mantles all receive energy from one bunsen burner, accuracy in their shapes and dimensions is of special importance. A limit of 1 to 2 millimetres either side of standard dimensions is quite feasible, and is necessary if all the mantles in a cluster lamp are to yield their maximum light.

The physics of cluster burners is of interest. The bunsen mixture is preheated before combustion, and there is also heat interchange between closely adjacent mantles. On the other hand there is some interference between mantles when placed very close together. (In his address Mr. Clark illustrated this point by photographs of clusters of mantles viewed vertically, horizontally and at an angle of 45°. The horizontal candle-power of two mantles $4\frac{1}{2}$ ins. apart was found to be 46.6 as compared with 52.5 for the same mantles $1\frac{3}{4}$ ins. apart —an increase of $12\frac{1}{2}$ per cent.)

A feature is the remarkable strength of the mantles now available. All things considered, the author favours the silk mantle, which is not easily damaged by contact. The depreciation in lighting power of a mantle is so small as to be negligible, provided the mantle is unbroken.

Modern Lighting Problems.

Artificial lighting may be divided into several broad classes, e.g., domestic, industrial, commercial, scientific, sports, etc. In shop lighting there has been a tendency towards the adoption of con-

* Abstract of an address delivered before the London and Southern District Junior Gas Association, April 24th, 1931.

cealed lighting, but there still remains a large body of opinion amongst business men that abundance of light outside their shops is a great advantage in attracting customers, and there seems no reason why this should not continue to be a field which can be served by gas.

By "scientific" lighting is meant the application of light for medical treatment. It is sometimes useful to have a source approximating to daylight, and the advantage offered by special mantles impregnated so as to emit wavelengths which are nearer to daylight than ordinary mantles has often been appreciated. There should be a field for mantles of this description, but it is an interesting point how far they should be used for domestic purposes.

There are now several gas lighting installations which permit of games, such as tennis, being played indoors. Gas lighting for this purpose has been applied successfully in South London by the South Metropolitan Gas Company. It appears that from the point of view of colour, illumination, steadiness and low cost, gas leaves little to be desired.

The British Standard Specification for Street Lighting.

In view of the public importance of street lighting this aspect of lighting is worthy of close consideration. The issue by the British Engineering Standards Association of the standard specification, and the establishment of the Association of Public Lighting Engineers, have contributed greatly to the general interest. Fine work has also been done by the Illumination Committee of the Department of Scientific and Industrial Research, under whose direction a subcommittee carried out investigations at Sheffield in 1928, and at Leicester last year. A specially favourable comment on gas lighting was made in the Sheffield report, although, unfortunately, gas was not included in the work done at Leicester.

It is interesting to observe the manner in which the British Engineering Standards Association street lighting specification has influenced this aspect of artificial lighting. Stress is laid upon the importance of minimum illumination; that is, the illumination provided at certain specified test points. This has tended to encourage the use of high-power units arranged so that the strong rays that reach the distant points are not so far removed from a horizontal line drawn through the centre of the light source. These rays, therefore, tend to enter the eyes of the pedestrians or drivers using the road, a result in direct conflict with recommendations which have been made in connection with lighting in factories, workshops, schools and similar places. It is true that the test point illumination value may be raised substantially in this way, but it is a matter of opinion whether the added glare does not more than neutralize this advantage.

Reflector Design.

Directive reflectors can be applied with advantage, but to use them to direct a powerful, but narrow, beam of light to a selected test point seems to be going too far. Another point is the attempt to screen lamps by opaque reflectors, so as to cut off the rays at angles sufficiently below the horizontal to prevent glare. A serious drawback to this is that if the lamp is suspended so that it can swing in the wind, the angle of cut-off varies, so that a flashing effect is produced at the midspan or test point, which is in some respects worse than the steady glare produced by directive reflectors.

Attempts have been made to lessen this effect by hanging from the edge of the reflector a curtain of diffusing glass. This seems a good idea, because, apart from lessening glare, it gives a better appearance to the lamp itself, and the appearance of a lamp in the street in the daytime as well as night is a matter of no little importance from the civic point of view.

Having in view recent practical experience, it appears that a number of points in the British Engineering Standards Association specification will need reconsideration. For instance, the allowable deterioration of 50 per cent. seems too much. I should like to see at least 70 per cent. as the minimum to which individual lamps should fall, based upon the declared contract value. It hardly seems reasonable to allow an installation to depreciate from a rated class to the minimum of the next lower one.

Another interesting point is that the illumination at the test points as defined by the British Engineering Standards Association can be substantially higher than the minimum illumination discoverable by a survey of the working area of the road. This surely was never intended. The specification has encouraged the use of devices giving powerful, but quite narrow, beams of light. This seems to be poor street lighting, but, as it is permissible under the specification, doubt must be thrown on the value of the recommendations as they now stand.

Appreciation is due to the British Engineering Standards Association Committee for its endeavours to define and measure glare. It is an important and difficult subject, and the work done at Sheffield and Leicester is of value. Gas lighting has, I consider, nothing to fear from the standpoint of glare. The circumstances call, however, for as much constructive criticism as is possible, and herein lies an opportunity for all gas men who wish to see gas continue as the premier street illuminant in this country.

Distribution of Light from Mantles.

It is many years ago now (1910) since I read a paper before this Association on the subject of radiation. In it was given a number of polar curves showing how light was distributed from units that were available in those days, and, again, in a later paper prepared jointly by Mr. Mackinney and myself, and read before the Illuminating Engineering Society in 1913, some further information was given. Since these occasions many changes have taken place, and it may be interesting to have some geometrical considerations governing the distribution of light from incandescent gas mantles. The mantles in common use nowadays are made in a form which consists of a cylinder having a hemisphere at its base.

(In the original paper Mr. Clark then presented some polar curves of light distribution and figures for the actual and calculated flux of light in the lower hemisphere showing how closely the latter, in general, agreed with the former.)

Rating of Illuminating Power.

The consideration of curves leads to the rating of lighting units. Any method adopted should be such as to encourage developments on sound lines, and should not allow freak appliances to take an undue share of credit. I have no faith in spherical values from a practical point of view, though scientifically they can be useful, especially for bare sources of light. Some data are presented in the adjacent table, which shows that horizontal candle-power is by no means a true index of the total light emitted from bare mantles. Nothing short of polar curves can be completely satisfactory.

There is a tendency to rate lamps by selecting from the polar curve the maximum value and applying this figure to the lamp. Provided the polar curve is given as well, this practice may be permissible. Sometimes the efficiency is stated in terms of B.Th.U. per candle-hour based on the lower hemispherical values, and this is a useful method of comparing lamps, though some care is necessary. The lower hemispherical value has the advantage of being directly applicable to the design of lighting installations. For example, a low-pressure single mantle unit consuming say 5 cubic ft. per hour of 500 B.Th.U. gas has an efficiency of 25 B.Th.U. per hour per hemispherical candle. This would yield in the lower hemisphere:—

$$\frac{4\frac{1}{2} \times 500}{25} \times 2\pi = 570 \text{ lumens}$$

With this information, together with the polar curve, the number and disposition of the units to give a certain illumination over a given area can be computed.

TABLE I, SHOWING THE FACTOR BY WHICH THE HORIZONTAL CANDLE-POWER OF UNITS MAY BE MULTIPLIED TO GIVE THE M.H.S.C.

Description of Lighting Unit			Maximum Horizontal Candle Power	M.S.C.P.	Ratio Mean Spherical / Horizontal
No. of Mantles	Size of Mantles	h/r Ratio of Mantles			
3	A	0·73	112	97·5	0·87
1	A	0·73	28·8	25·7	0·89
1	B	1·09	30·7	27·7	0·90
1	C	0·71	35·8	33·2	0·92
1	E	1·00	82	69·3	0·86
2	C	0·71	100	76·4	0·76
(every 20° in horizontal plane)					
5	C	0·71	161	154	0·96

The ratios in the last column represent the factors by which the horizontal candle-power must be multiplied to obtain the mean spherical value.

In carrying out some tests in schools several years ago, computations were made based upon the lumens found on the desk plane divided by the hourly rate of gas consumption for all the lamps in the room. The ratio giving lumens per cubic ft. per hour of 500 B.Th.U. gas did not vary between wide limits, namely, between 100 and 120, although the diversity of the illumination did. The diversity is a question of height and spacing.

Future Developments.

It is always interesting to speculate on the probable future changes. We ought always to keep in mind that the luminous emission from a mantle is proportional to the 12th power of the temperature. It means that an increase of 1 per cent. in the temperature of the mantle will increase the yield of light by 12 per cent. Having regard to the mechanism of combustion of gases, one is also tempted to think of the possible effect of turbulence in accelerating the combustion and thereby raising the flame temperature. It is not unlikely that turbulence coupled with complete mixing of the gas and air accounts in some measure for the added light obtainable by high-pressure gas. Again, it has always been suspected that the gas mantle acts as a catalyst, and Professor Lewes demonstrated this possibility years ago. It may be that some progress along this line is possible.

Like all sources of heat, the gas burner sets up convection currents which might have drawbacks if the burner is placed near a ceiling. The impact of the convection currents is evidenced by the darkening of the ceiling. This point is worthy of investigation. It is well-known that the dark stain is due to dust suspended in the air. If, therefore, the amount of air passing through the burner is reduced to a minimum, the darkening effect upon the ceiling might be lessened. One can imagine a lighting burner designed to emit its hot products of combustion at the bottom of the globe or shade, somewhat after the lines of the bottom flue outlet cooker.

Notes on the National Safety First Congress

A correspondent sends us some impressions of the proceedings at the National Safety First Congress, which was held in Leeds during last month. At the corresponding Congress held last year a paper dealing with street lighting in relation to accidents was read by Mr. R. Beveridge. On this occasion no paper dealing specifically with lighting seems to have been read, if we except the analysis by Mr. R. L. Matthews of "Traffic Control by Light Signals," which, however, refers to Leeds only.

The summary by Mr. F. G. Bristow of the Principal Safety Provisions of the Road Traffic Act, 1930, was naturally of importance to motorists and local authorities, but to the lighting expert it is somewhat disappointing to observe that there is apparently not a word about lighting within. The same might almost be said to apply to the otherwise informative analysis of Causes of Street Accidents compiled by Lieut.-Colonel J. A. A. Pickard. The solitary reference to lighting as a possible factor in the causation of accidents is indirect—i.e., in the figures quoted in two lines in regard to accidents occurring by day and by night, which are as follows:

	1928. Per cent.		1927. Per cent.
In daylight	85.5	...	87.7
During hours of darkness...	14.5	...	12.3

To our mind, considering the fact that, during a great part of the night, there is almost no traffic in the streets and no pedestrians are about, the proportion of accidents occurring at night is quite considerable. It may also be significant that the percentage of night-accidents rose materially in 1928 as compared with the previous year—a tendency that has previously been noted in this journal.

The paper by Mr. Matthews consisted mainly of a description of methods of applying light signals adopted in Leeds, and a general discussion of their advantages. In the early part of the paper attention is drawn to several evident drawbacks of the system of imposing the task of traffic control on police officers. The work is very laborious and not infrequently—when there is poor visibility—dangerous. It also withdraws valuable men who might be put to better use elsewhere. In Leeds 25 constables have been released from traffic duty as a result of the introduction of light signals. It is also believed that safety at crossings has been improved and traffic conditions made easier. This is encouraging so far as it goes. One would, however, like to get evidence from other cities where light-signals have been installed, and especially definite figures in regard to the number of accidents that occurred annually before and after the change.

Mr. H. A. Lingard Joins the Board of the B.T.-H.

Mr. H. A. Lingard, who has just been appointed a director of The British Thomson-Houston Co. Ltd., first entered the service of the company in 1904 in the Turbine Works at Rugby. In 1915 he joined the Export Department.

For the last three years Mr. Lingard has been General Manager of the Mazda Lamp Sales Department, in which capacity he has become very widely known throughout the commercial sections of the electrical industry.

The above illustration depicts the Glassware Exhibit furnished by Messrs Hailwood & Ackroyd Ltd. for the British Glassware Exhibition at Selfridges, during April 10th-25th. Whilst the photograph suggests that this was an impressive exhibit it does not, of course, reveal the colouring, which was one of the chief features of the display.

SHERINGHAM DAYLIGHT.

Not very much has been heard recently of the Sheringham Daylight, which is based on the scientific combination of pigments, so as to yield reflected light closely resembling daylight. We have, at various times, referred to this interesting system, and we have now before us a leaflet showing that the method has been recently applied to a considerable variety of reflectors, amongst which the Sheringham-treated Benjamin R.L.M. corrective reflector deserves special mention. We also notice a trough-shaped drawing-board reflector, which should give a well-diffused light. The leaflet is illustrated by a pleasing colour-inset showing the appearance of a Chinese porcelain vase by daylight, Sheringham Daylight and uncorrected electric light.

STREET LIGHTING CONTRACTS.

We are informed that two contracts of considerable importance have been obtained by Messrs. Holophane Ltd. for the public lighting of Valparaiso (South America) and Durban (South Africa).

CONTRACTS CLOSED.

The following contracts are announced:—

THE BRITISH THOMSON-HOUSTON CO. LTD.:—

The Port of London Authority; for three months' supply of Mazda vacuum and gas-filled lamps.

SIEMENS ELECTRIC LAMPS AND SUPPLIES LTD.:

The Irish Free State Department of Local Government; for 12 months' supply of Siemens electric lamps.

Hull Corporation Tramways; for a year's supply of Siemens traction lamps.

London & North Eastern Railway; for 12 months' supply of Siemen's vacuum, gas-filled and carbon-filament lamps.

Epsom Urban District Council Electricity Department; for Siemens electric lamps for 12 months.

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